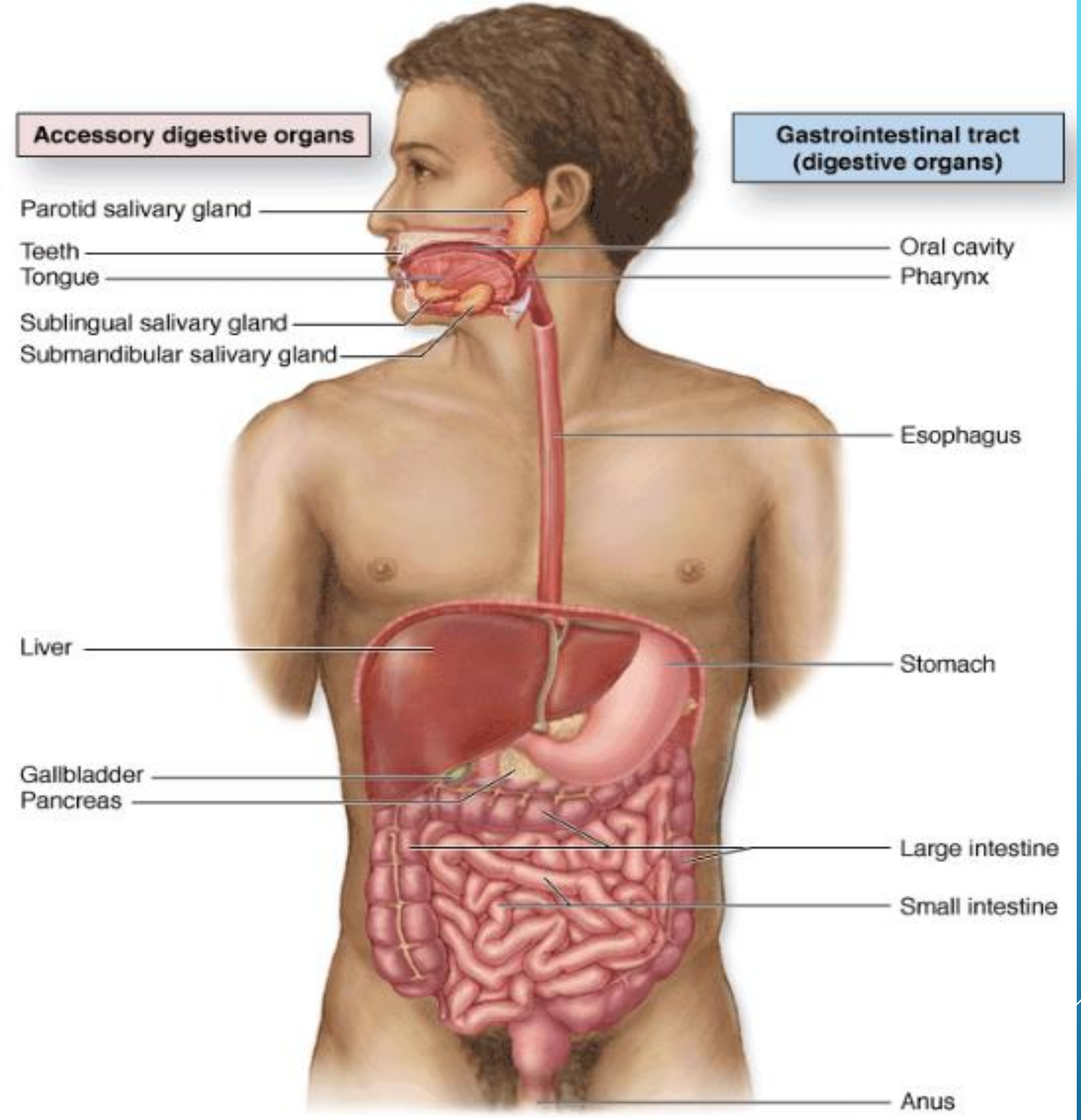
SMILE

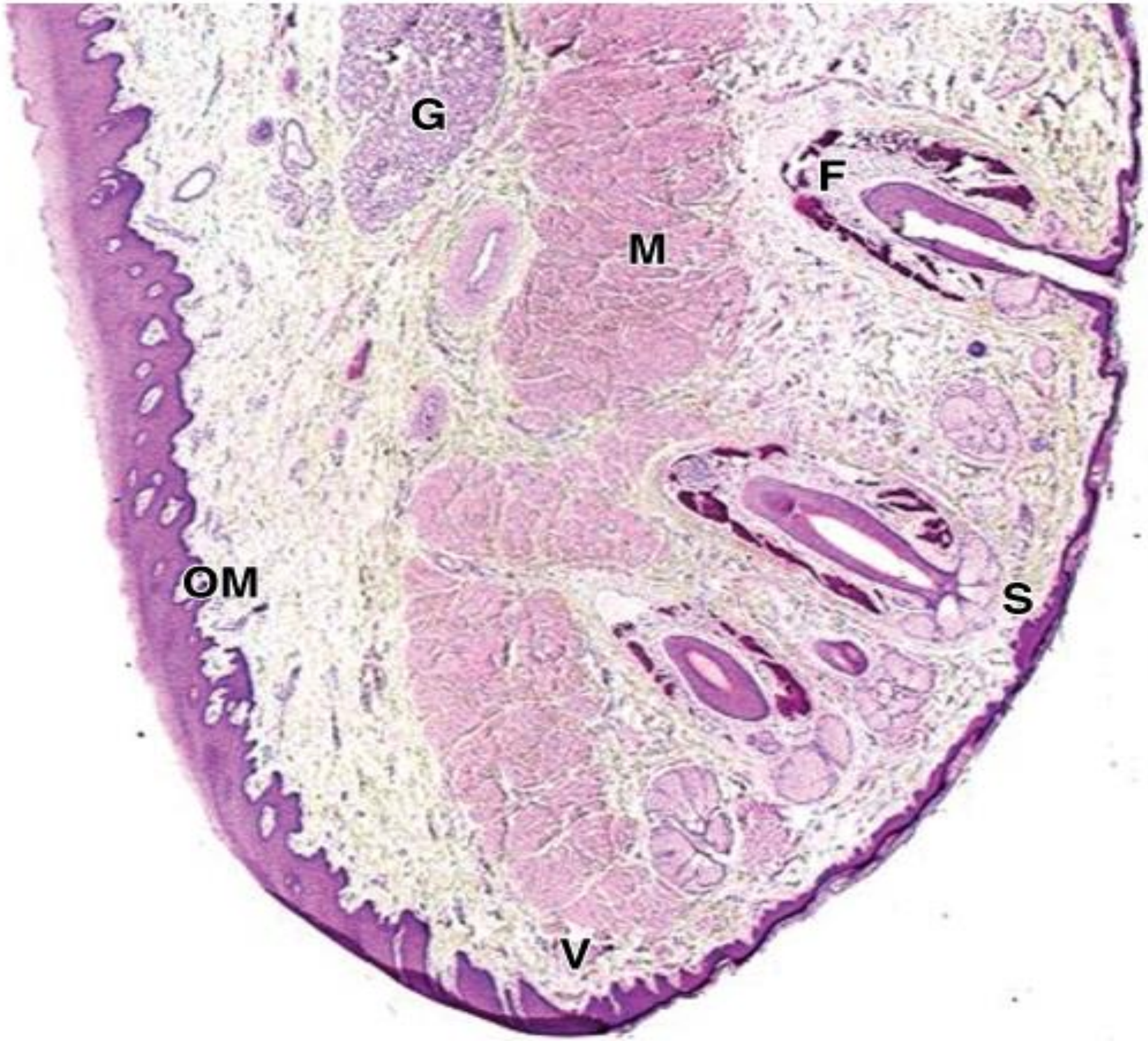
GIT HISTOLOGY IN PICTURES

BY; AM



Accessory digestive organs
Gastrointestinal tract
(digestive organs)
Parotid salivary gland
Teeth
Tongue
Sublingual salivary gland
Submandibular salivary gland
Oral cavity
Pharynx
Esophagus
Liver
Stomach
Gallbladder
Pancreas
Large intestine
Small intestine
Anus

THE LIP



THE LIP

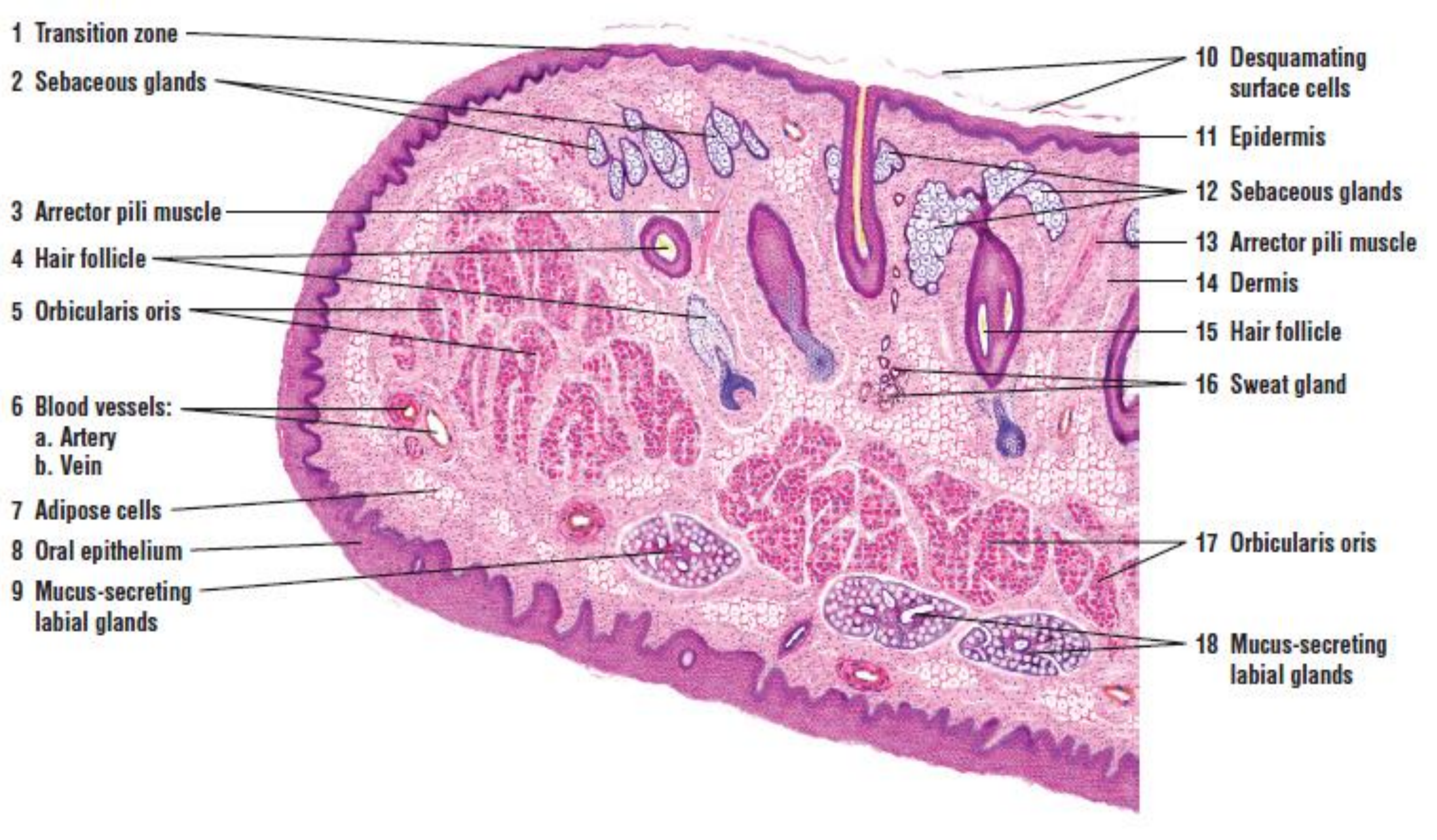
OM : oral mucosa

G : minor salivary glands

M : striated muscle

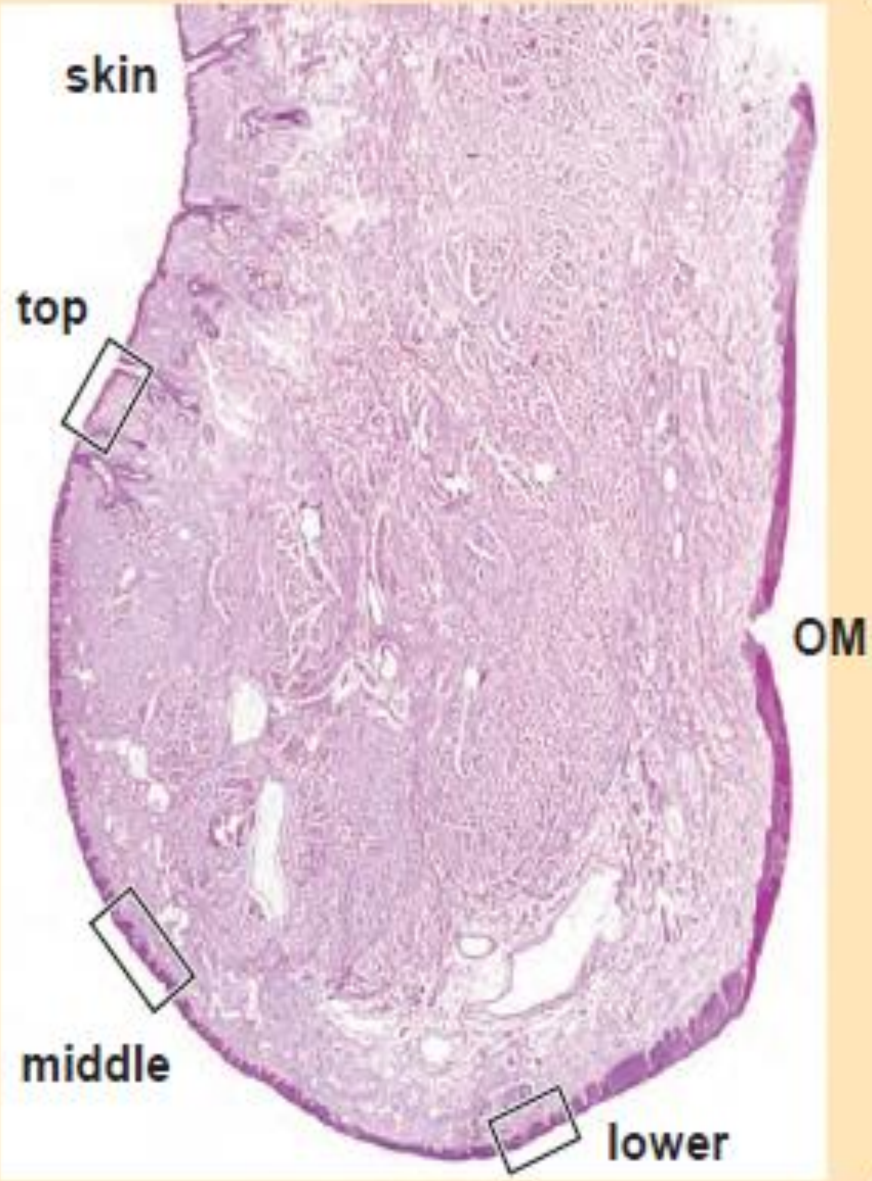
F : hair follicles

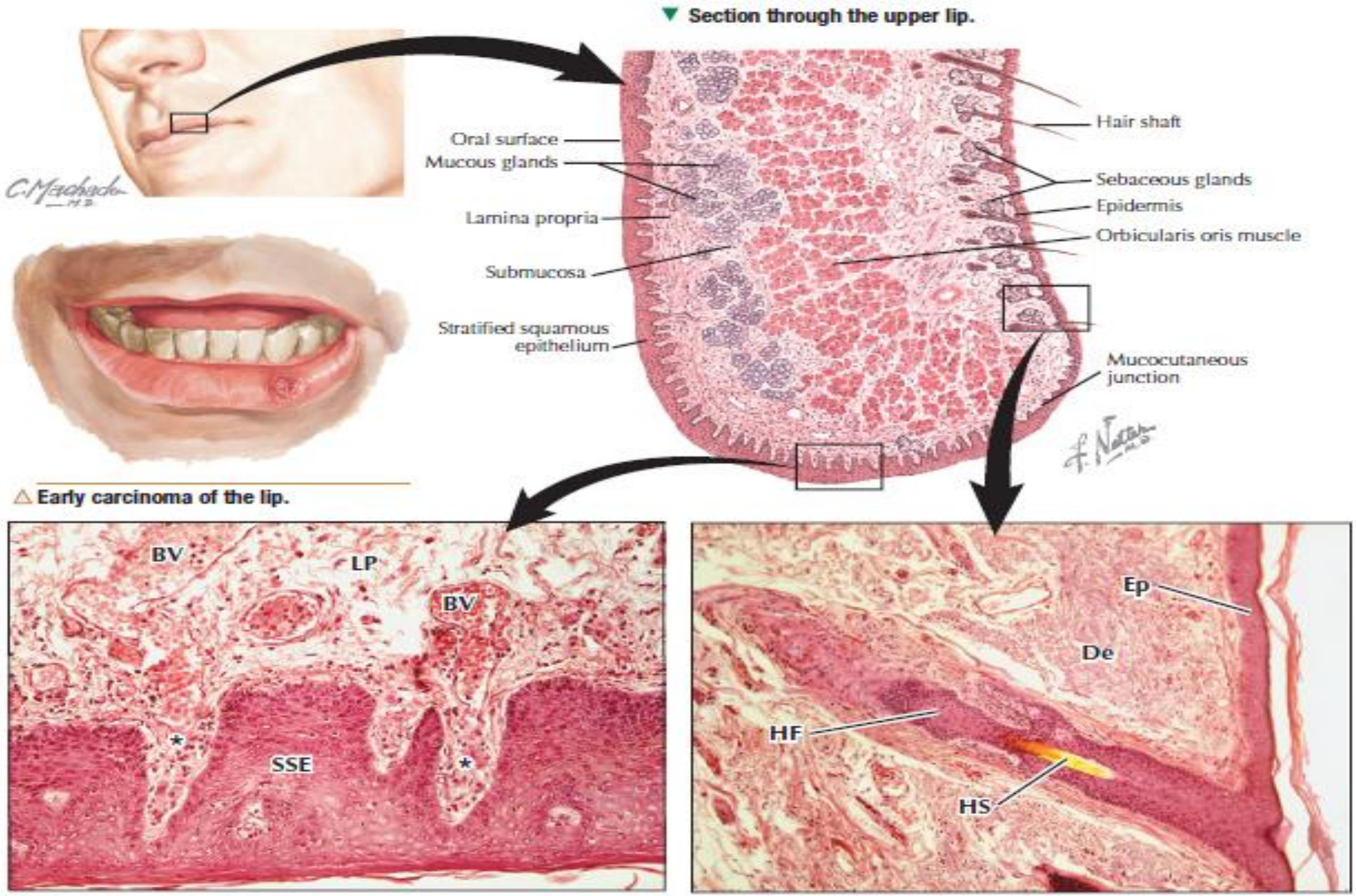
S : skin


1 Transition zone
2 Sebaceous glands
3 Arrector pili muscle
4 Hair follicle
5 Orbicularis oris
6 Blood vessels:
a. Artery
b. Vein
7 Adipose cells
8 Oral epithelium
9 Mucus-secreting labial glands
10 Desquamating surface cells
11 Epidermis
12 Sebaceous glands
13 Arrector pili muscle
14 Dermis
15 Hair follicle
16 Sweat gland
17 Orbicularis oris
18 Mucus-secreting labial glands

The **lips** are the entry point of the alimentary canal. Here, the thin **keratinized epithelium** of face skin changes to the thick **parakeratinized epithelium** of the oral mucosa. At the mucocutaneous junction, the red portion of the lips, is characterized by deep penetration of connective tissue papillae into the base of the **stratified squamous keratinized epithelium**. The blood vessels and nerve endings in these papillae are responsible for both the color and the exquisite touch sensitivity of the lips.

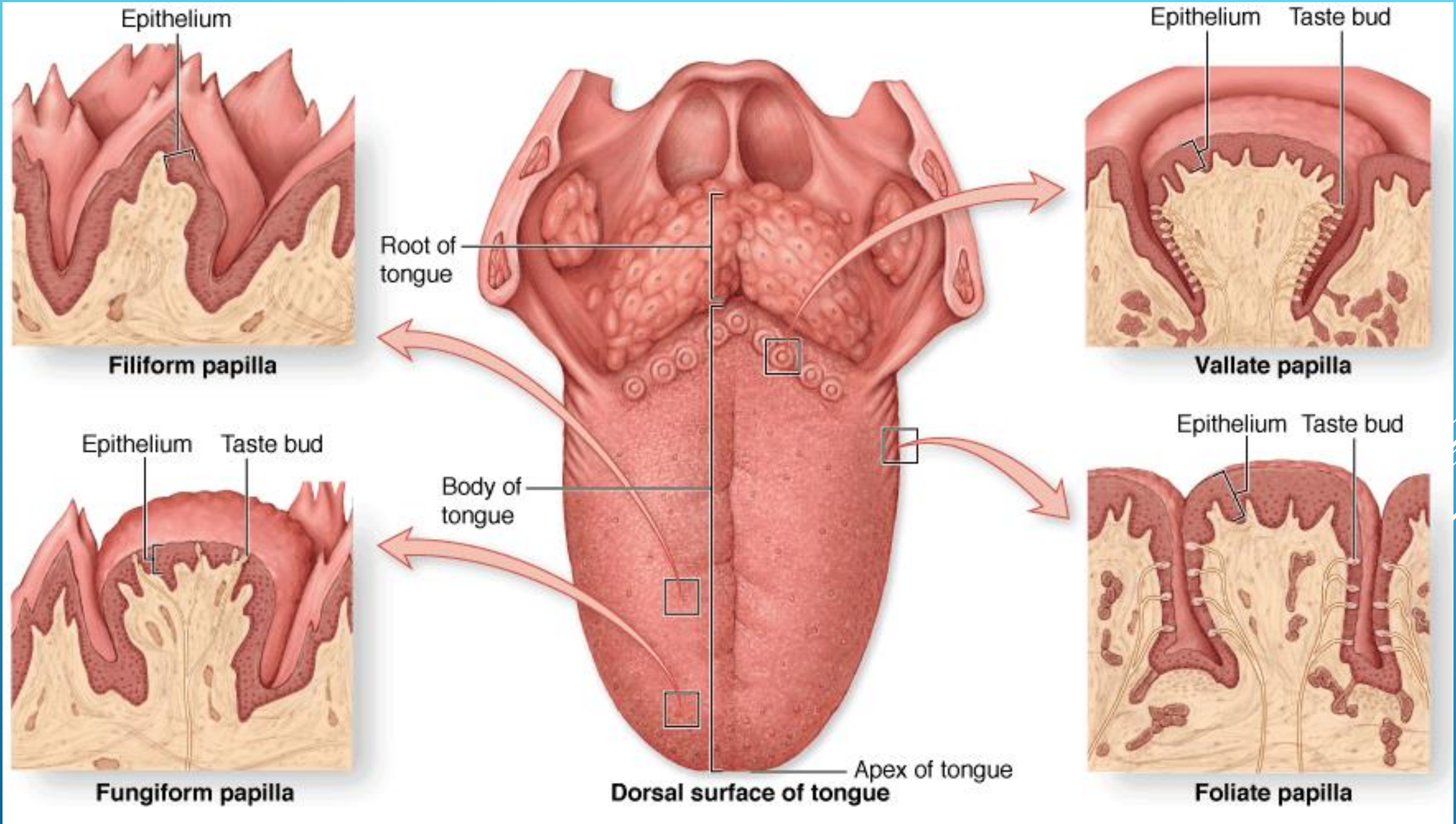
ORIENTATION MICROGRAPH: An H&E–stained sagittal section through the upper lip in this low-power orientation photomicrograph to the right (×8) reveals the skin of the face, the red margin of the lip, and the transition to the oral mucosa *(OM)*. The *marked rectangles* indicate representative areas of each of these sites, shown at higher magnifications in upper, middle and lower rows of figures, on the adjacent plate. Note the change in thickness of the epithelium from the exterior or facial portion of the lip (the vertical surface on the right) to the interior surface of the oral cavity (the surface beginning with *rectangle marked lower* and continuing down the left surface of the lip) in this micrograph.

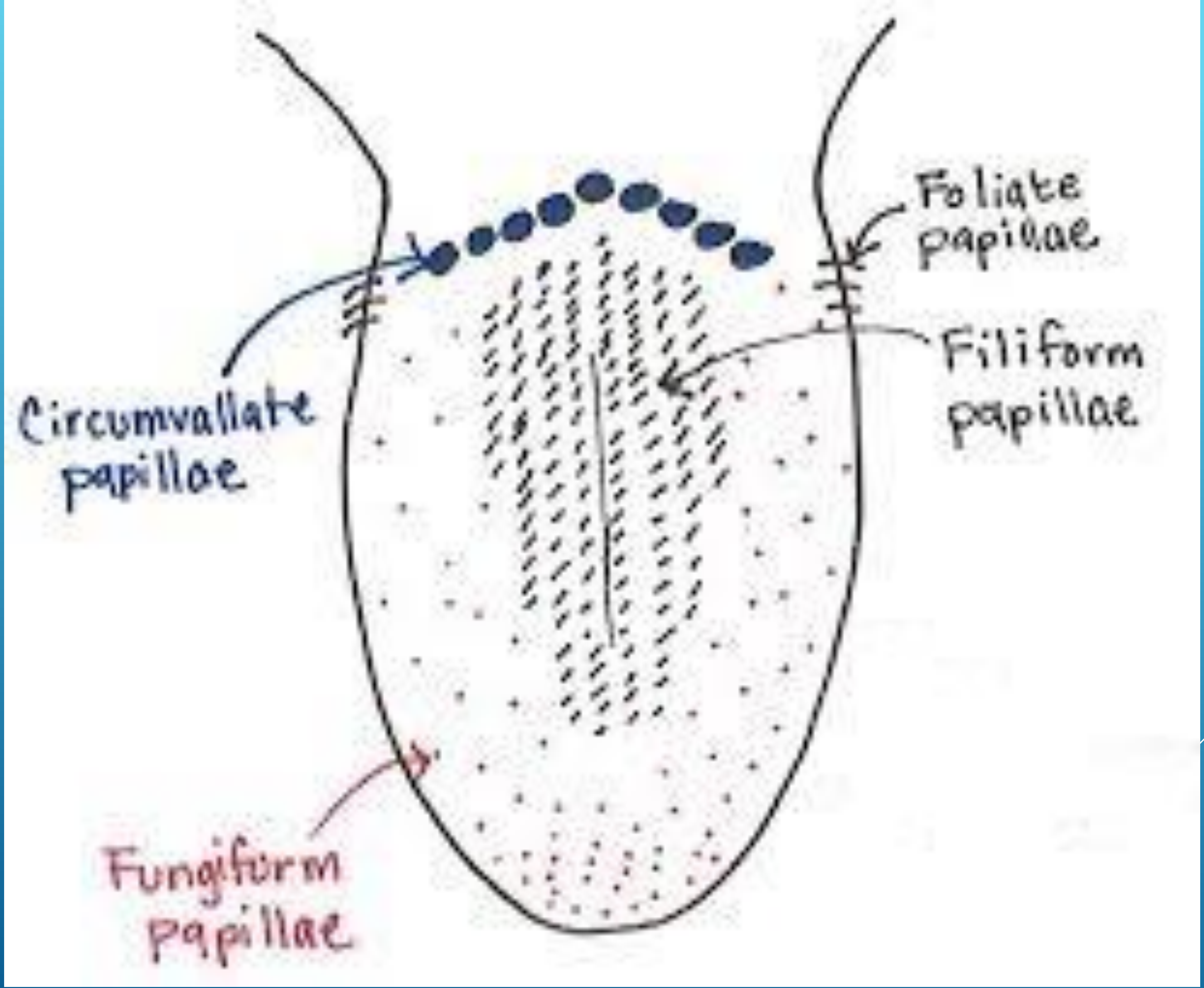




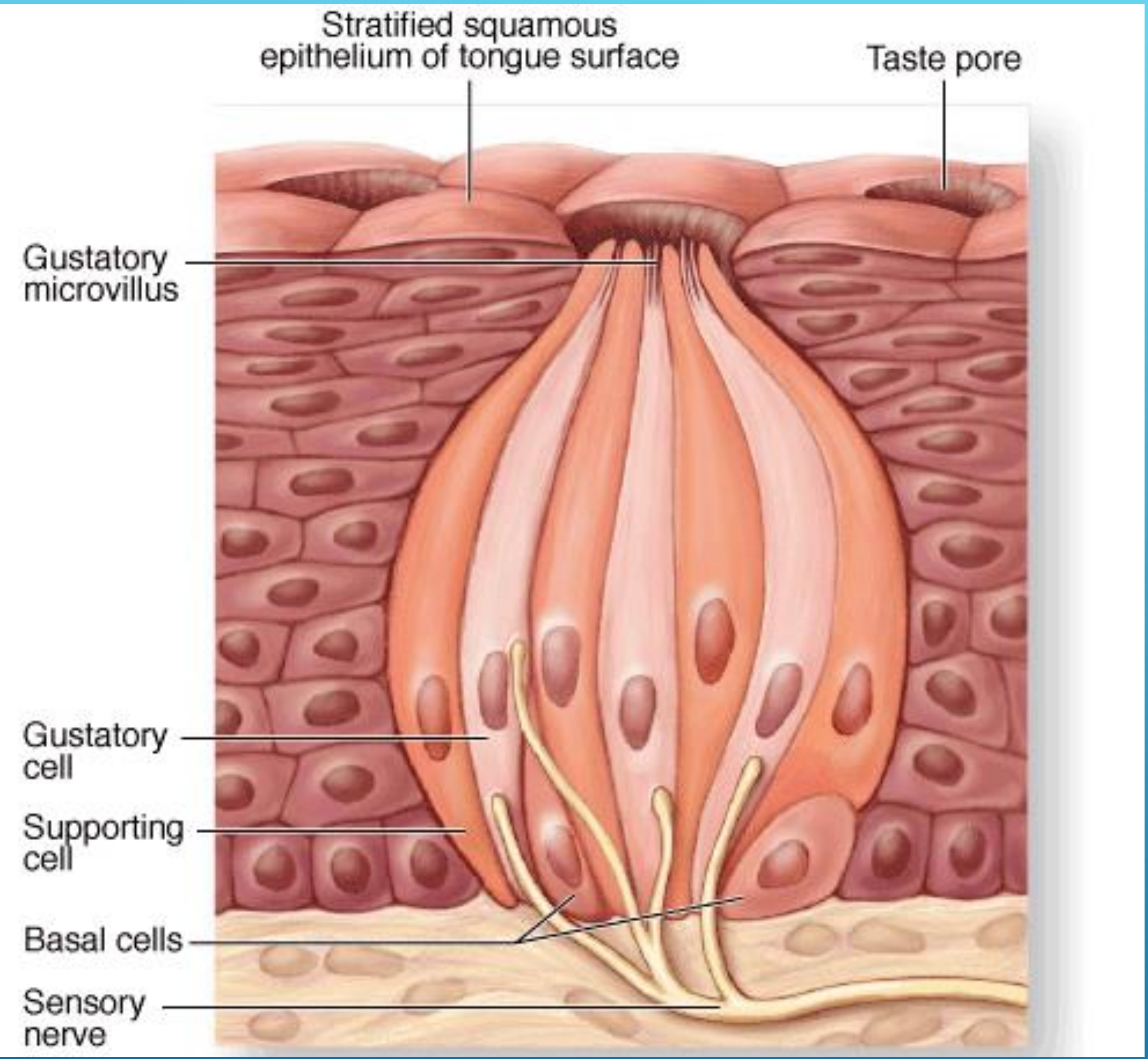
▲ **LMs of parts of the lip. Left**, The vermilion border is stratified squamous epithelium (**SSE**) with a thin layer of surface keratin, below. Underlying connective tissue—lamina propria (**LP**)—contains many blood vessels (**BV**). The highly corrugated interface between epithelium and connective tissue shows tall papillae (*) penetrating the epithelium to take capillaries close to the surface. **Right**, The external cutaneous surface, of typical thin skin, consists of epidermis (**Ep**) and underlying dermis (**De**). A hair follicle (**HF**) and associated hair shaft (**HS**) are seen. **Left**: 130×; **Right**: 85×. *H&E.*

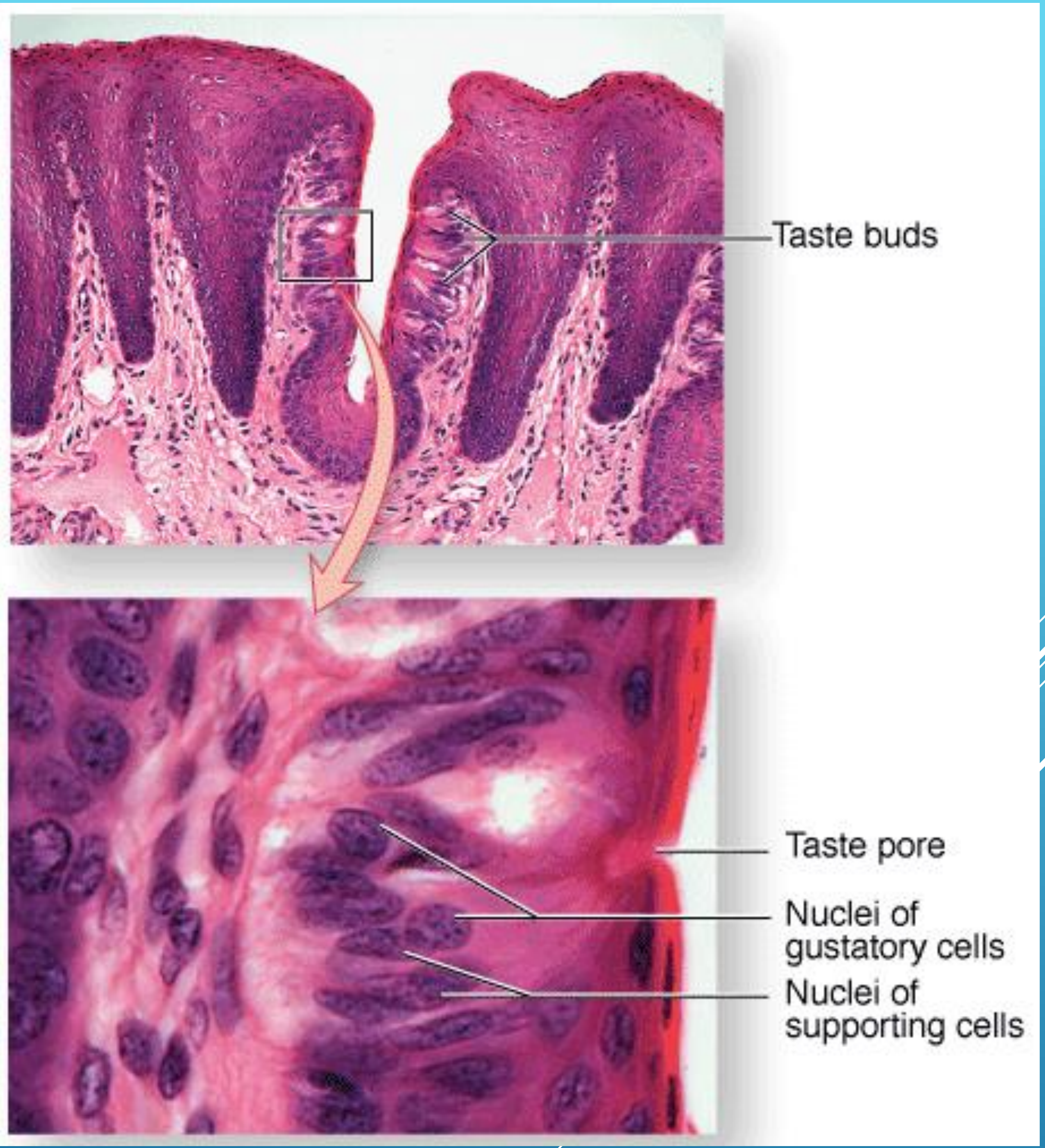
THE TONGUE


Epithelium
Filiform papilla
Epithelium
Taste bud
Fungiform papilla
Root of tongue
Body of tongue
Apex of tongue
Dorsal surface of tongue
Epithelium
Taste bud
Vallate papilla
Epithelium
Taste bud
Foliate papilla

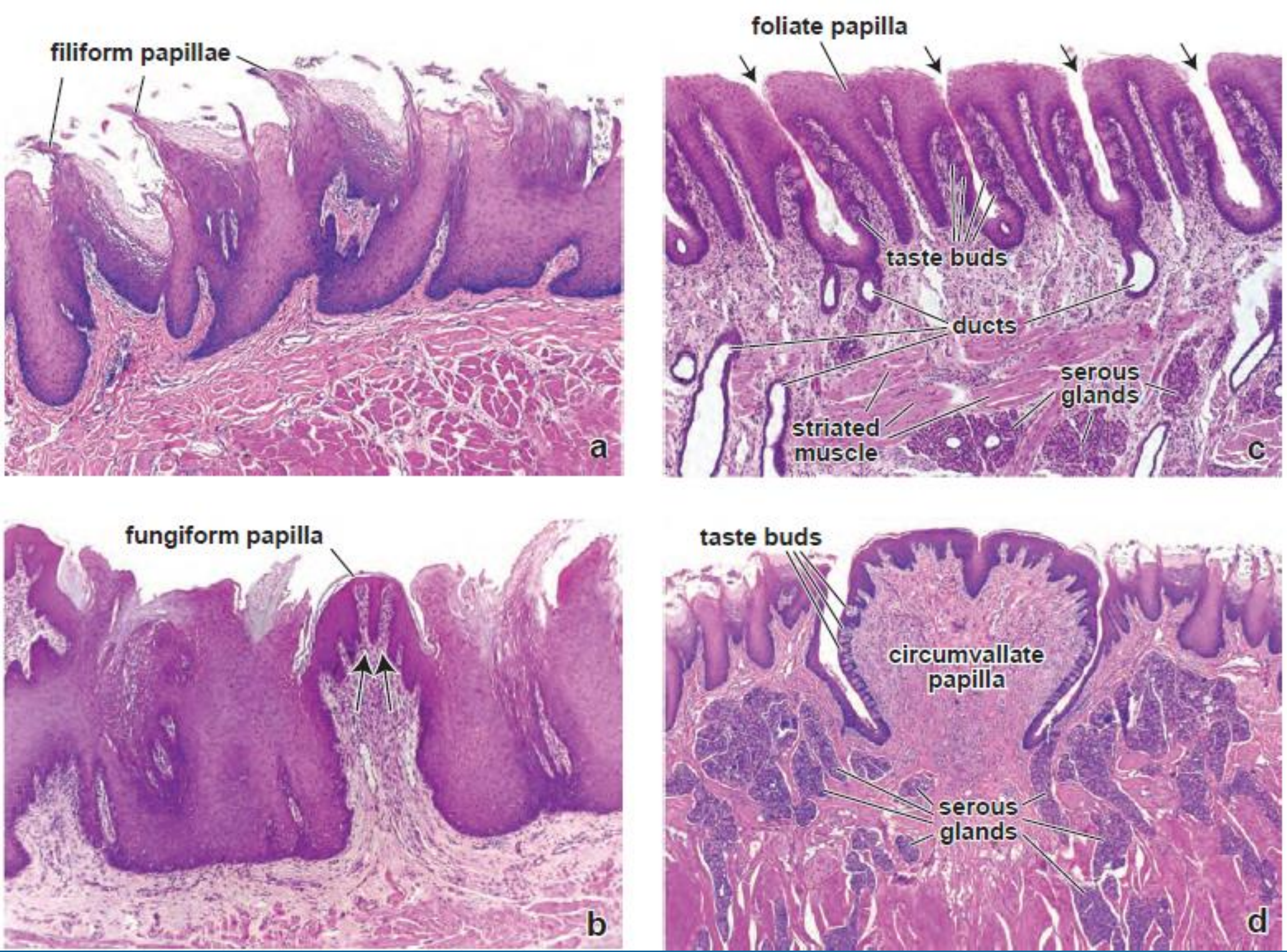


Circumvallate papillae
Foliate papilae
Filiform papillae
Fungiform papillae


Stratified squamous
epithelium of tongue surface
Taste pore
Gustatory
microvillus
Gustatory
cell
Supporting
cell
Basal cells
Sensory
nerve


Taste buds
Taste pore
Nuclei of
gustatory cells
Nuclei of
supporting cells

TASTE BUDS


filiform papillae
a
foliate papilla
taste buds
ducts
serous
glands
striated
muscle
c
fungiform papilla
b
taste buds
circumvallate
papilla
serous
glands
d

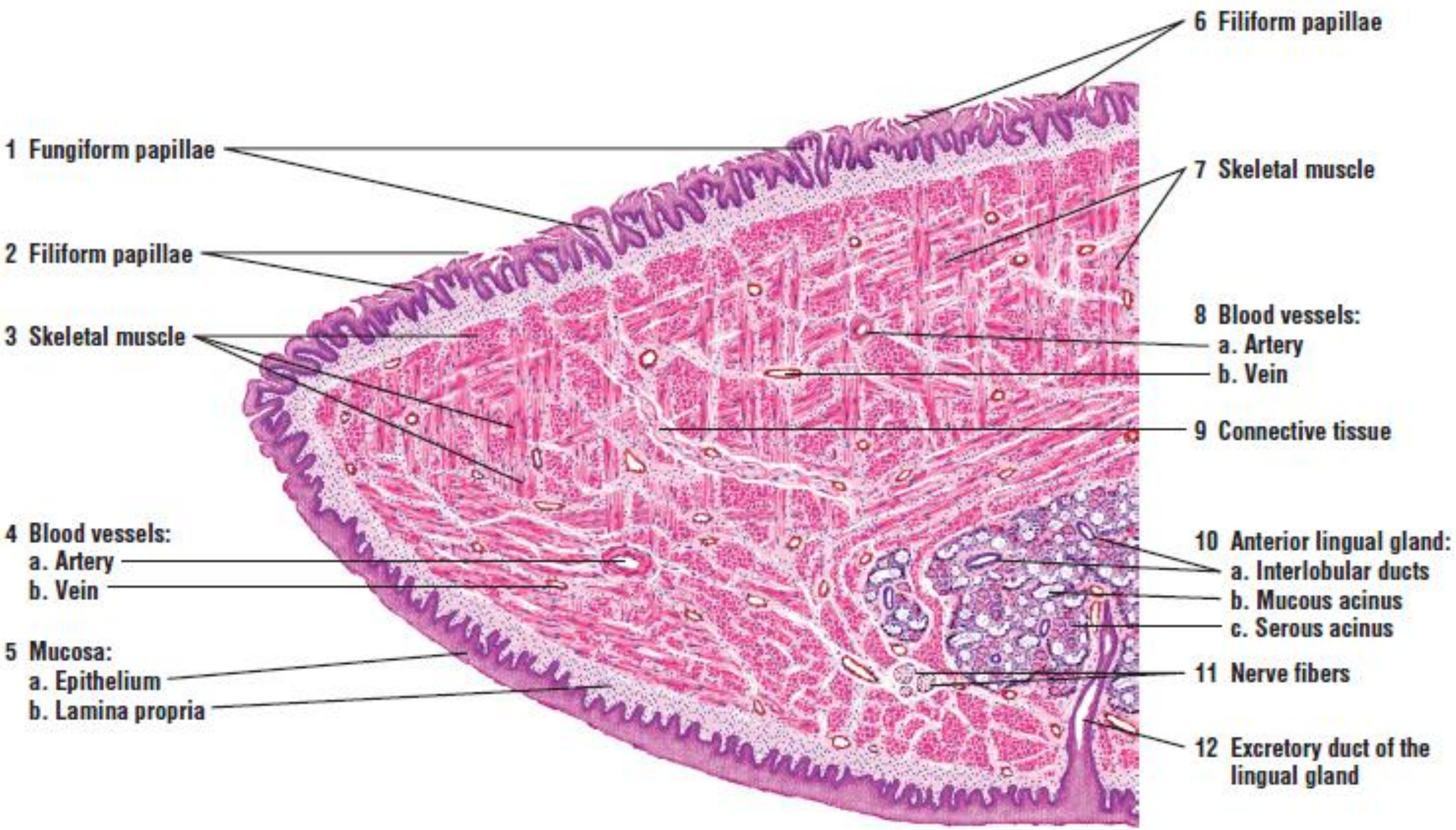


FIGURE 13.2 ■ Anterior region of the tongue: apex (longitudinal section). Stain: hematoxylin and eosin. Low magnification.

FIGURE 13.3 ■ Tongue: circumvallate papilla (cross section). Stain: hematoxylin and eosin. Medium magnification.

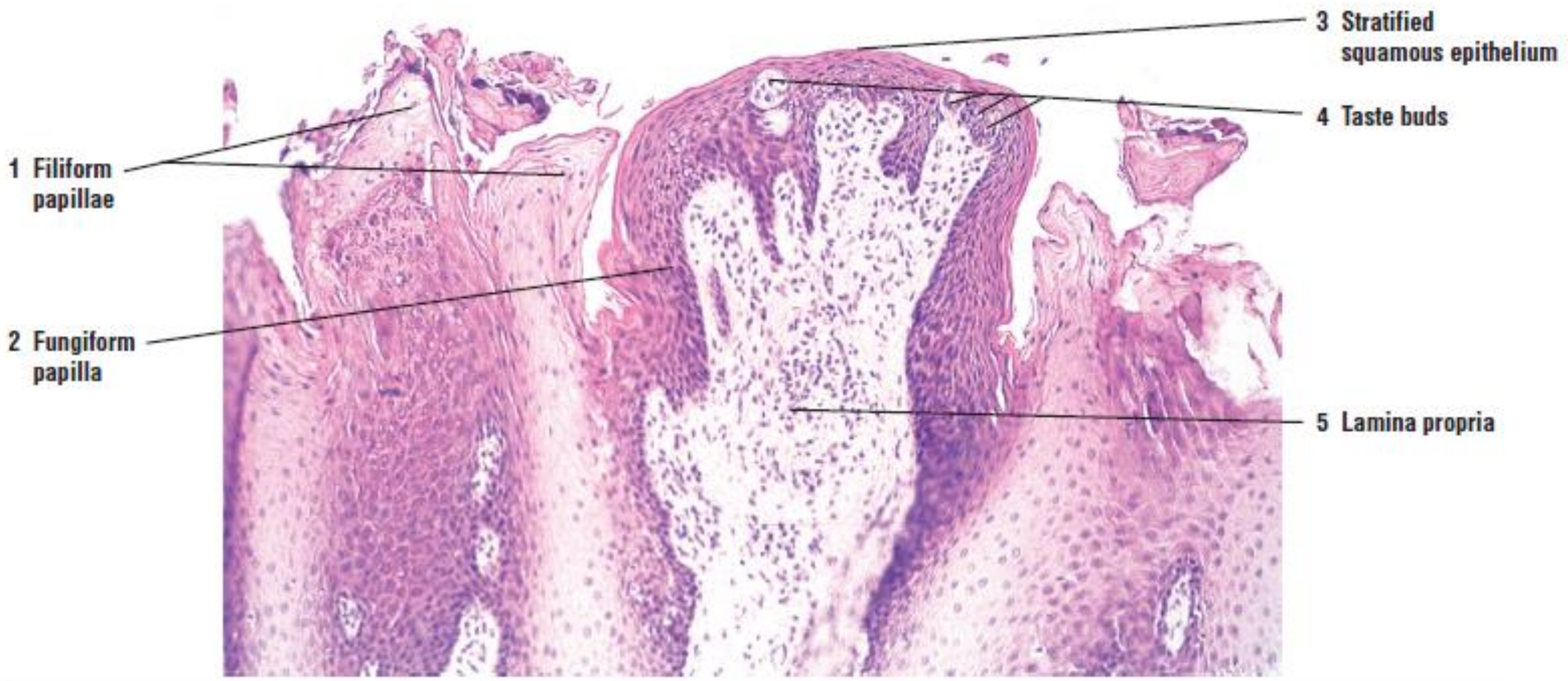


FIGURE 13.4 ■ Tongue: filiform and fungiform papillae. Stain: hematoxylin and eosin. ×25.

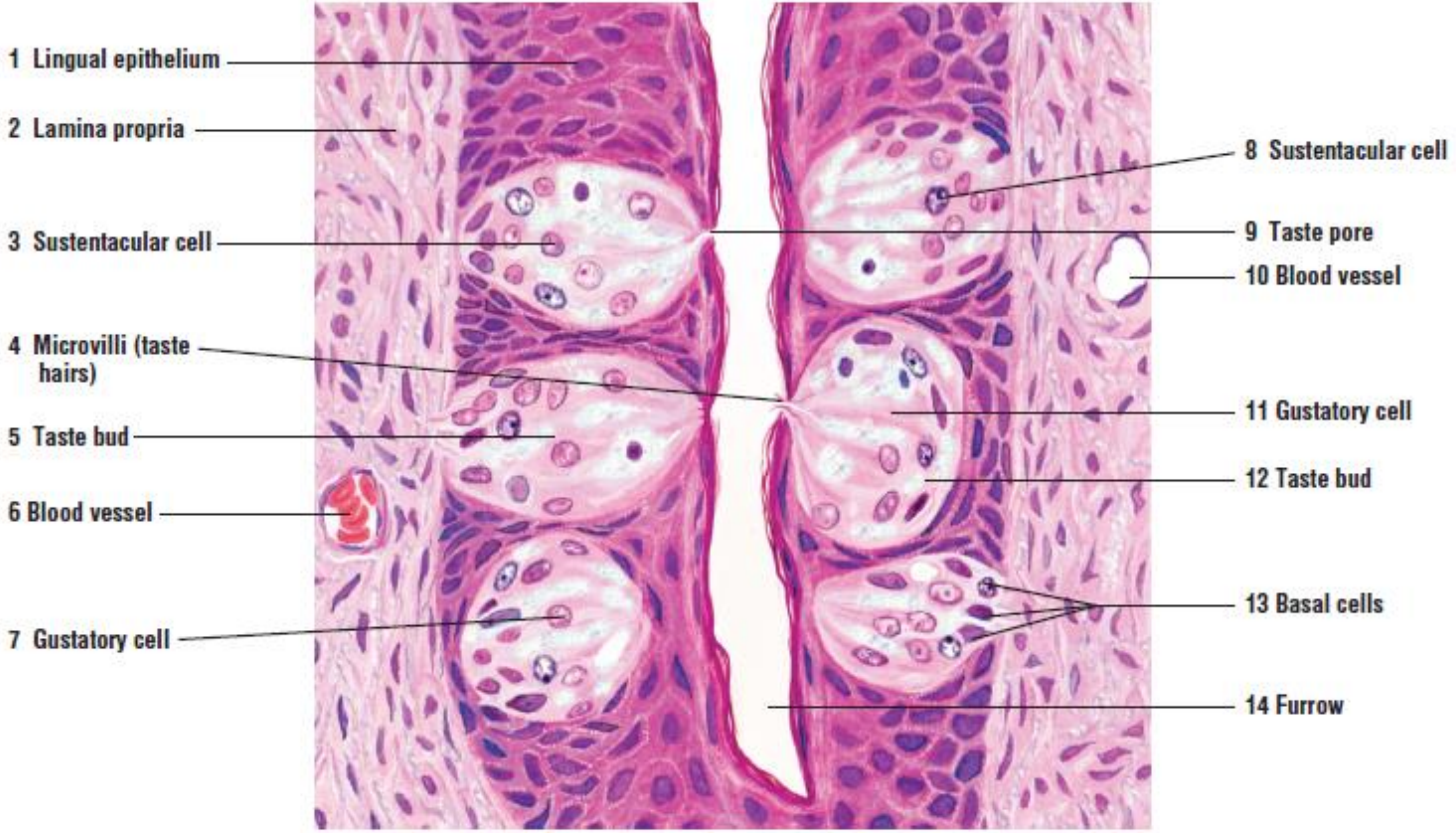
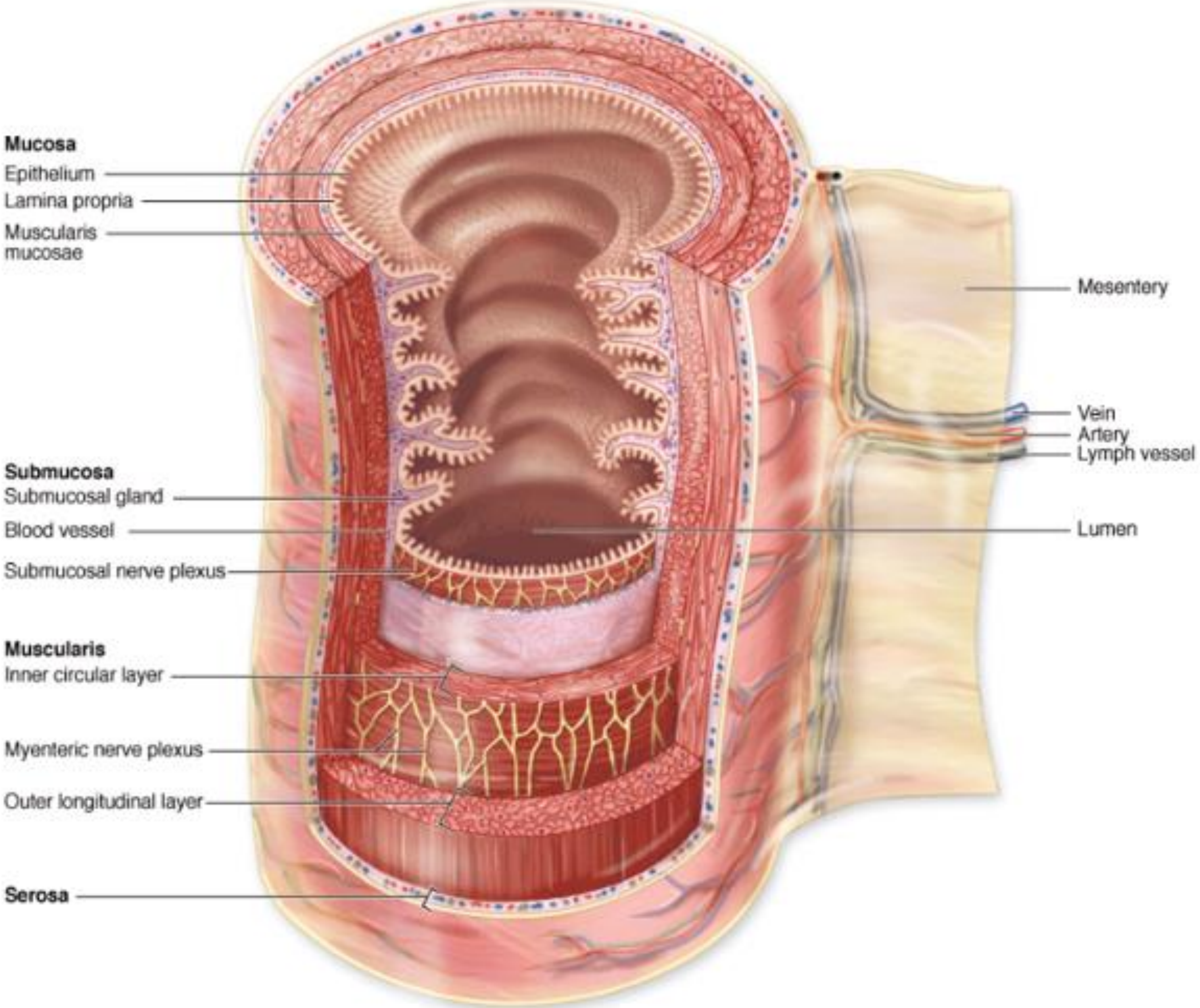
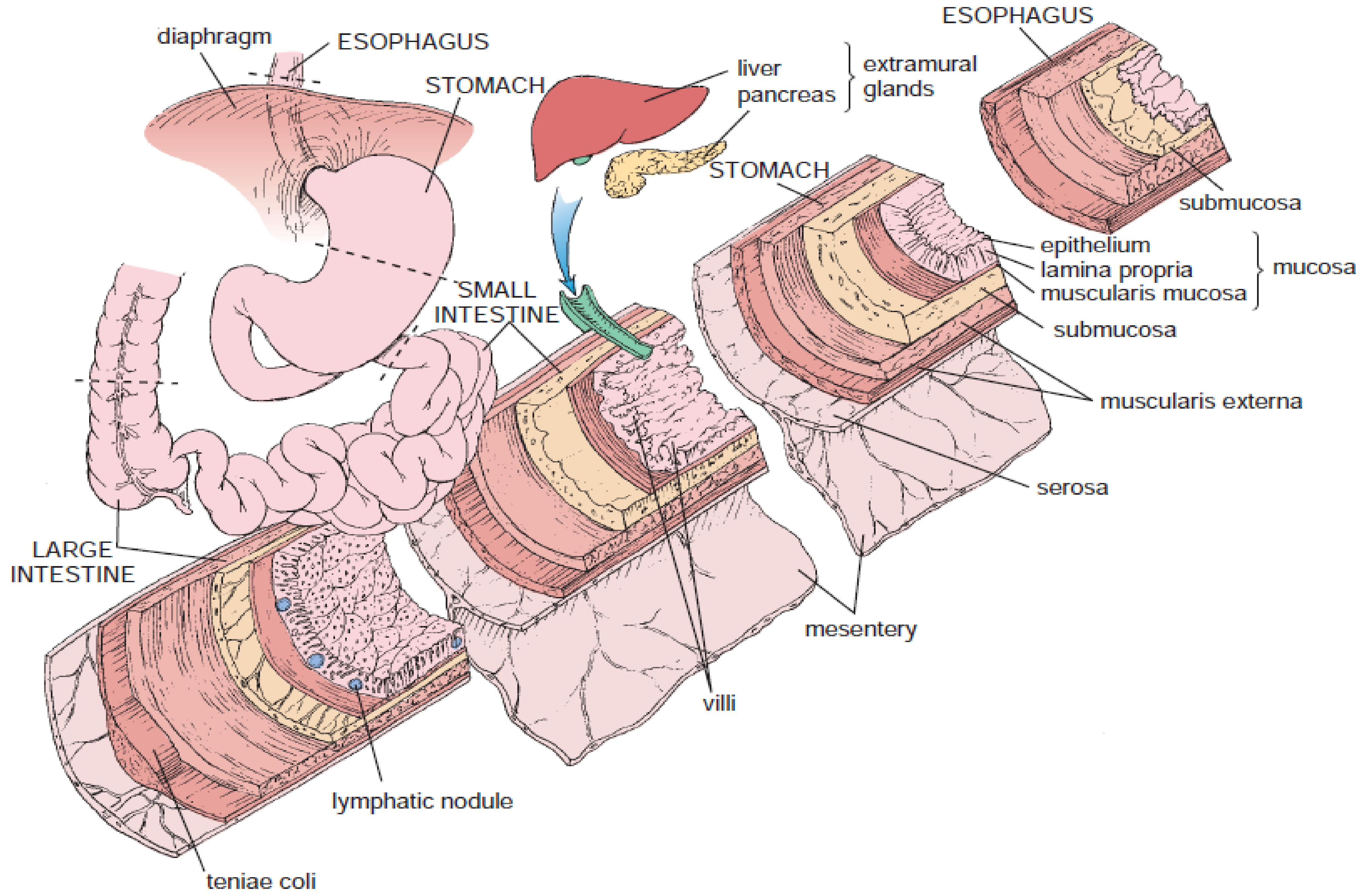


FIGURE 13.5 ■ Tongue: taste buds. Stain: hematoxylin and eosin. High magnification.

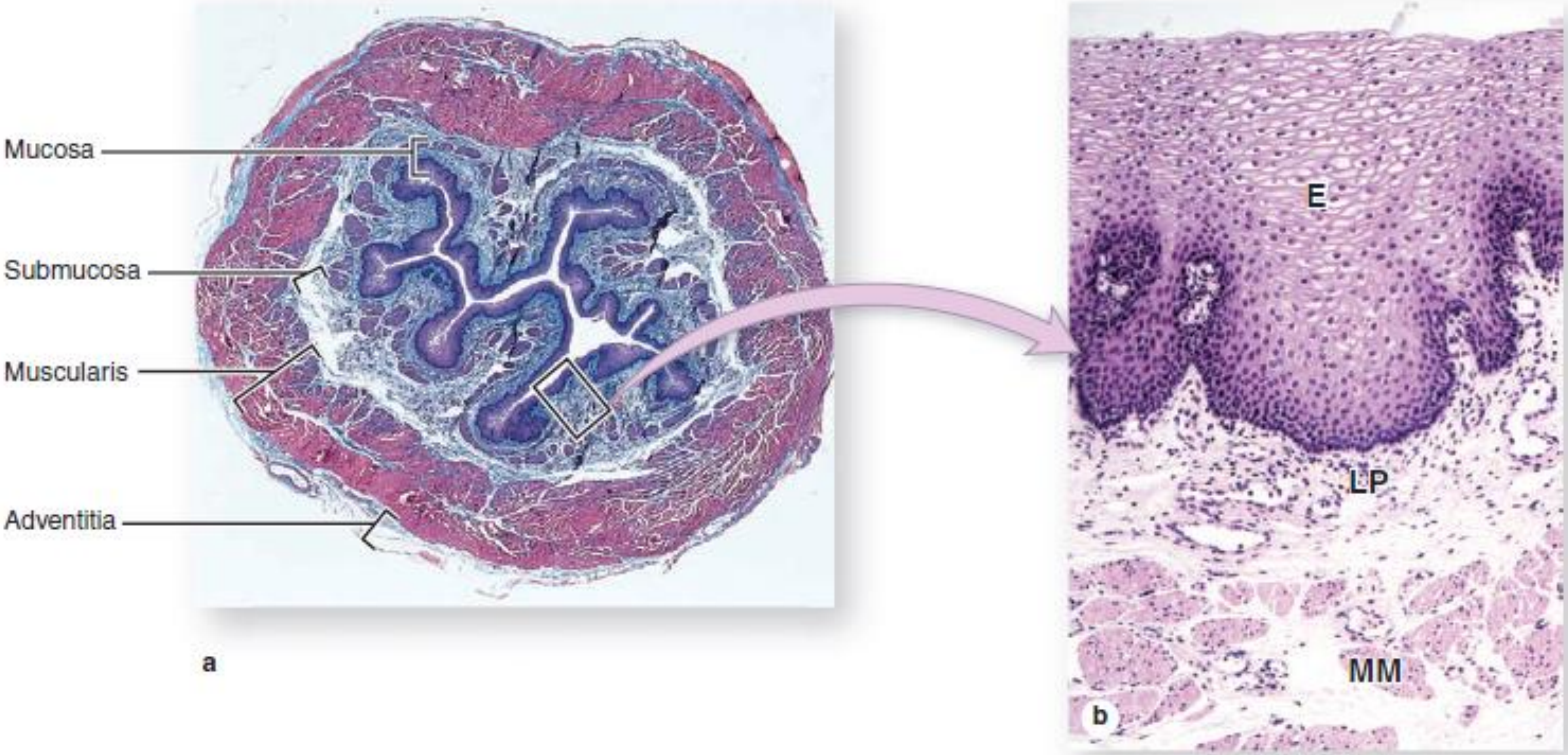
THE ALIMENTARY CANAL

Major layers and organization of the digestive tract

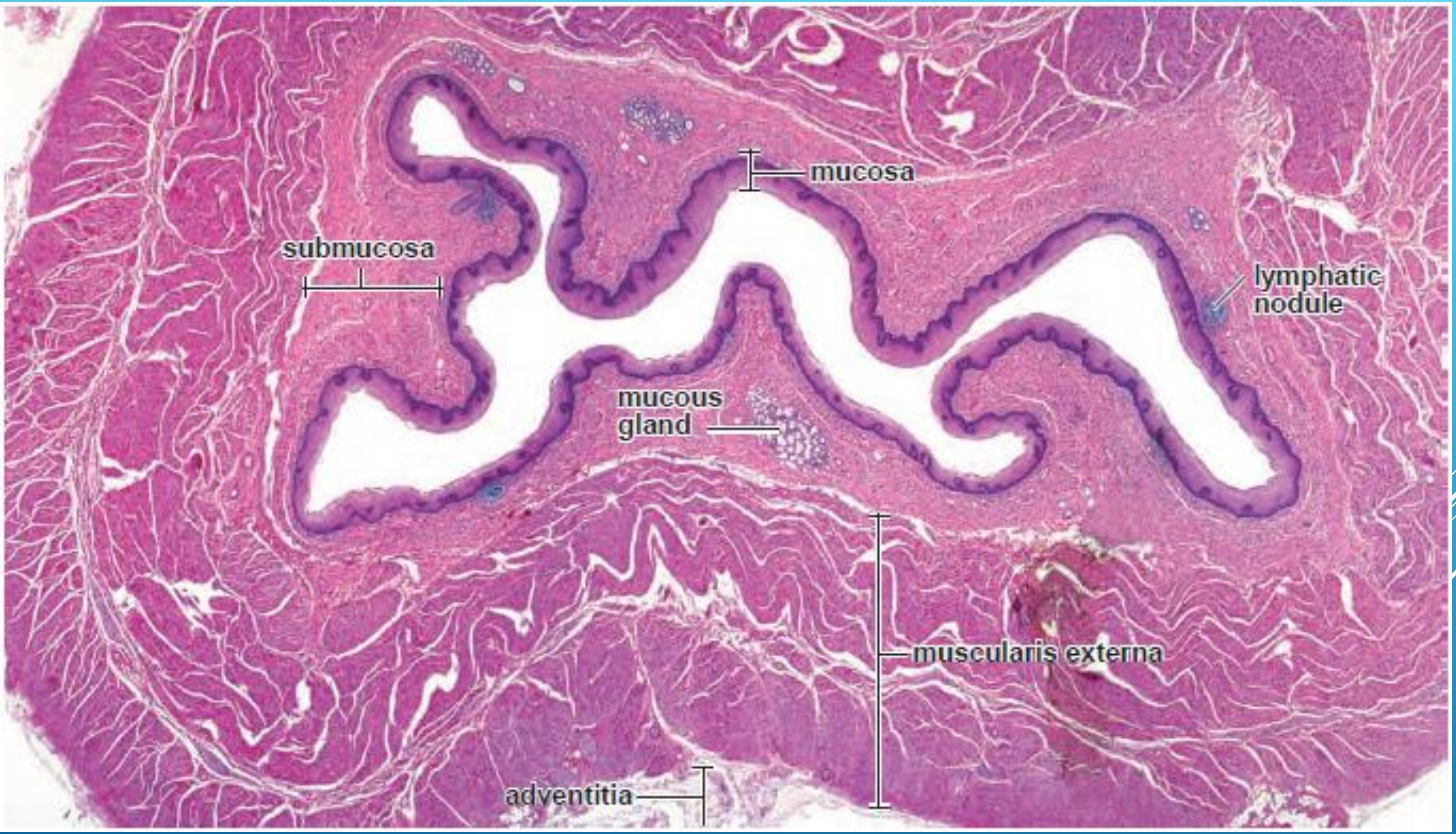


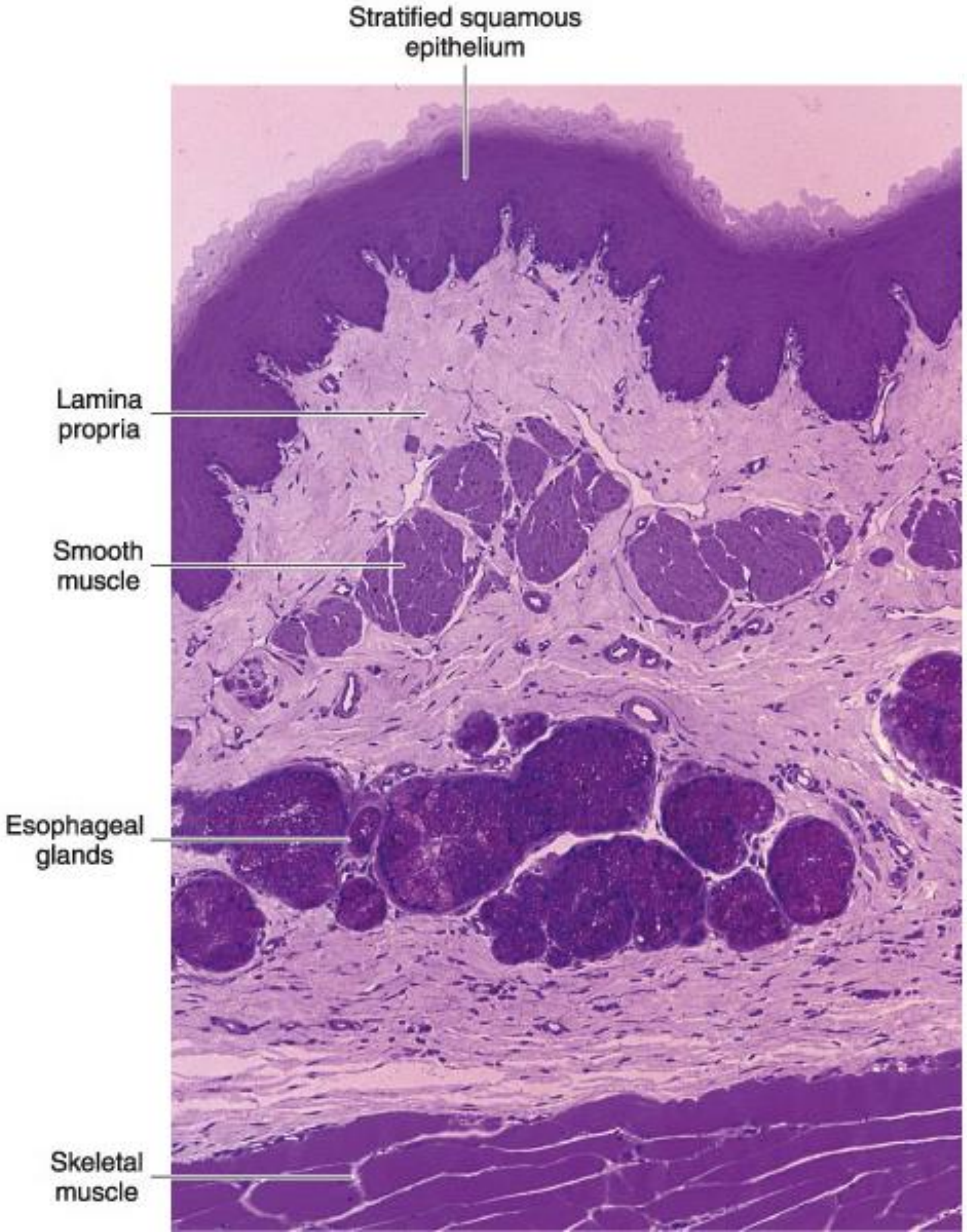

diaphragm
ESOPHAGUS
STOMACH
liver
pancreas
extramural glands
ESOPHAGUS
submucosa
STOMACH
epithelium
lamina propria
muscularis mucosa
mucosa
submucosa
SMALL INTESTINE
muscularis externa
serosa
LARGE INTESTINE
mesentery
villi
lymphatic nodule
teniae coli

THE ESOPHAGUS

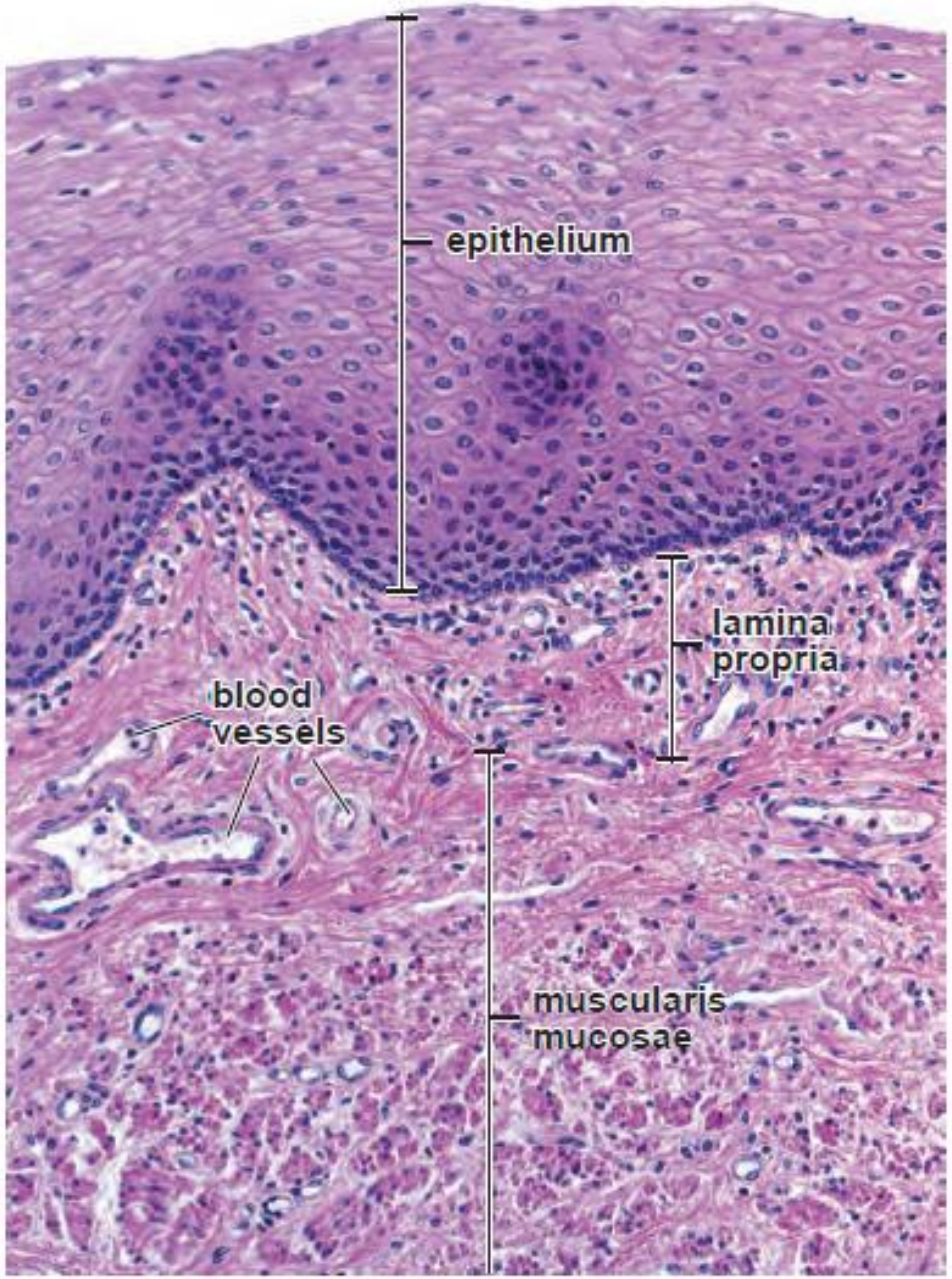


(a) In cross section the four major layers of the GI tract are clearly seen. The esophageal mucosa is folded longitudinally, with the lumen largely closed. X10. H&E. **(b)** Higher magnification of the mucosa shows the stratified squamous epithelium (**E**), the lamina propria (**LP**) with scattered lymphocytes, and strands of smooth muscle in the muscularis mucosae (**MM**). X65. H&E.

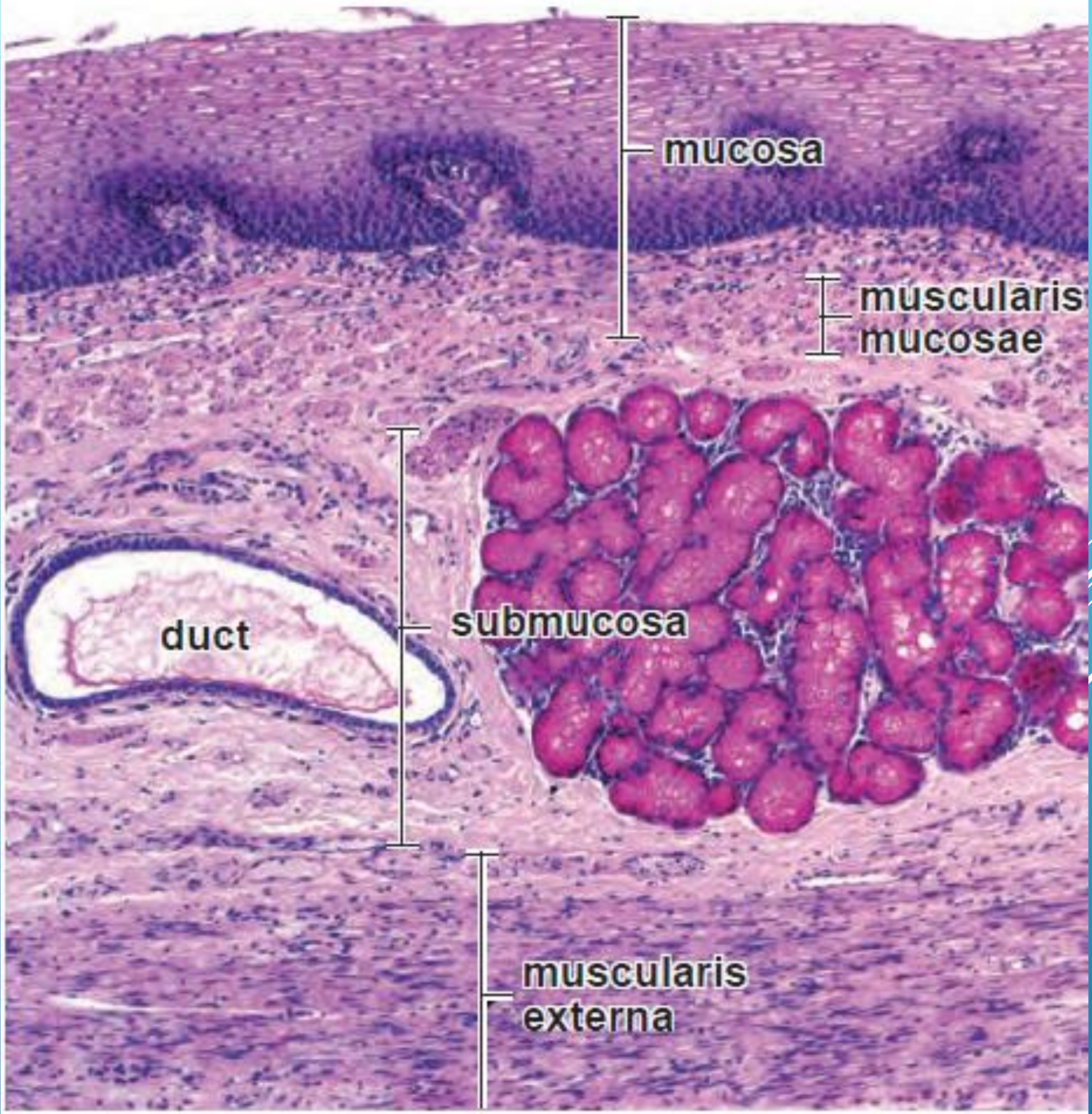

mucosa
submucosa
lymphatic nodule
mucous gland
muscularis externa
adventitia



Photomicrograph of a section of the upper region of the esophagus ...



Photomicrograph of the esophageal mucosa



Photomicrograph of an esophageal submucosal gland

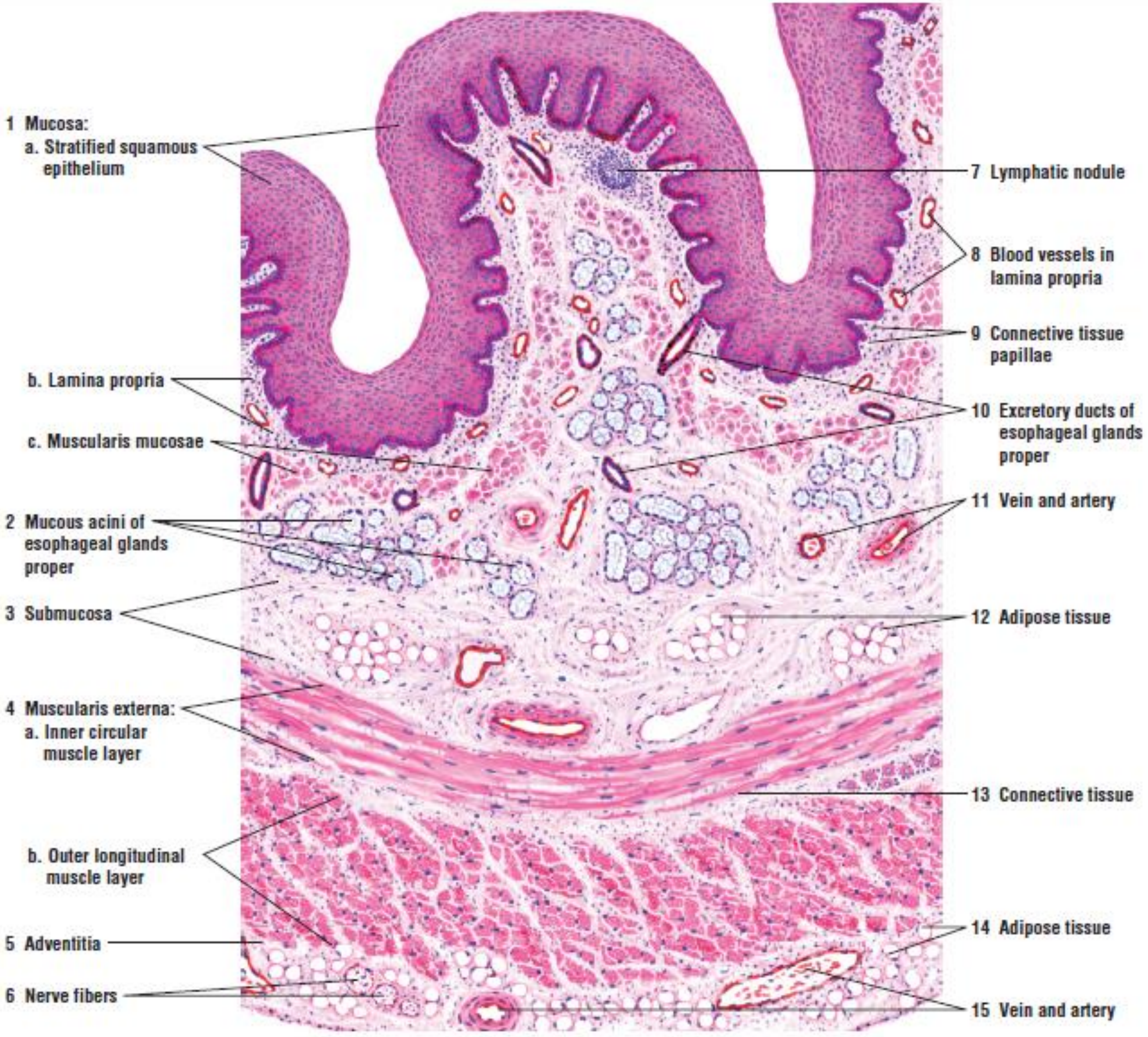


FIGURE 14.1 ■ Wall of the upper esophagus (transverse section). Stain: hematoxylin and eosin. Low magnification.

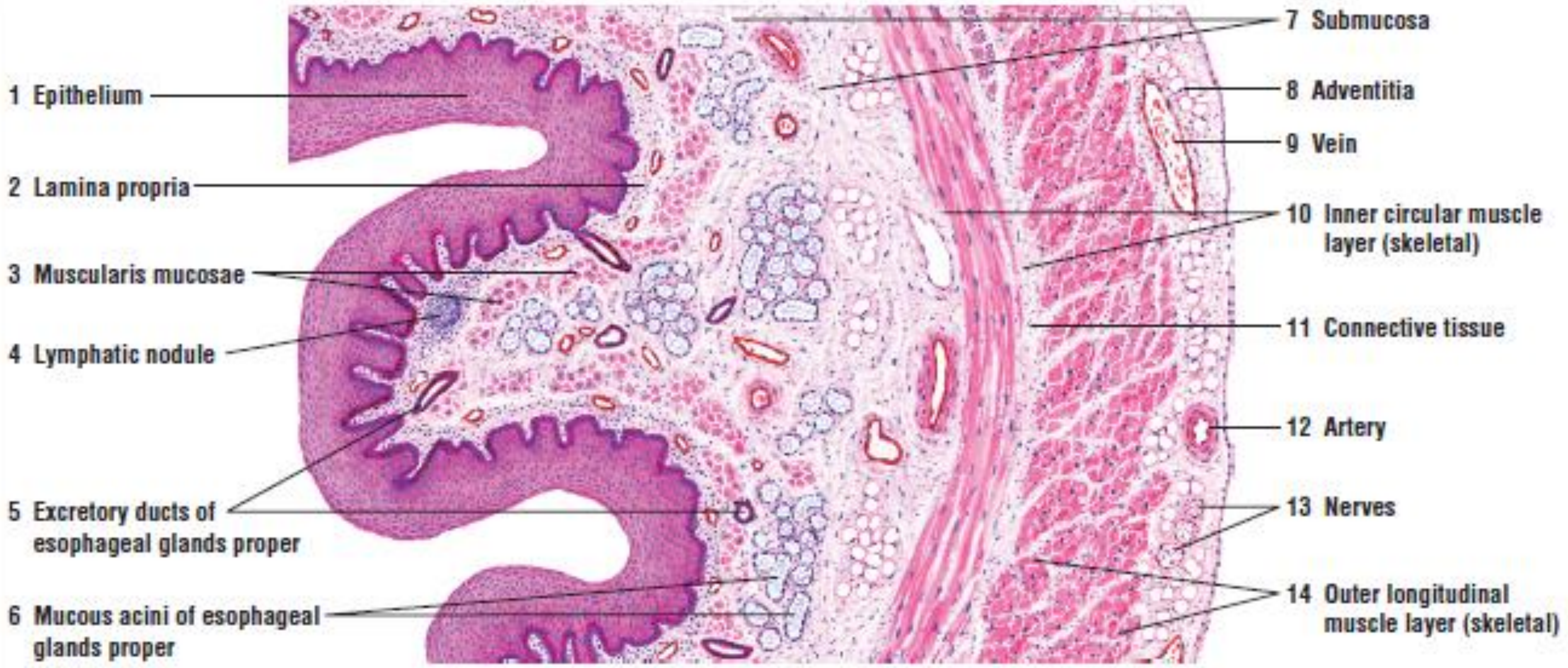


FIGURE 14.2 ■ Upper esophagus (transverse section). Stain: hematoxylin and eosin. Low magnification.

FIGURE 14.3 ■ Lower esophagus (transverse section). Stain: hematoxylin and eosin. Low magnification.

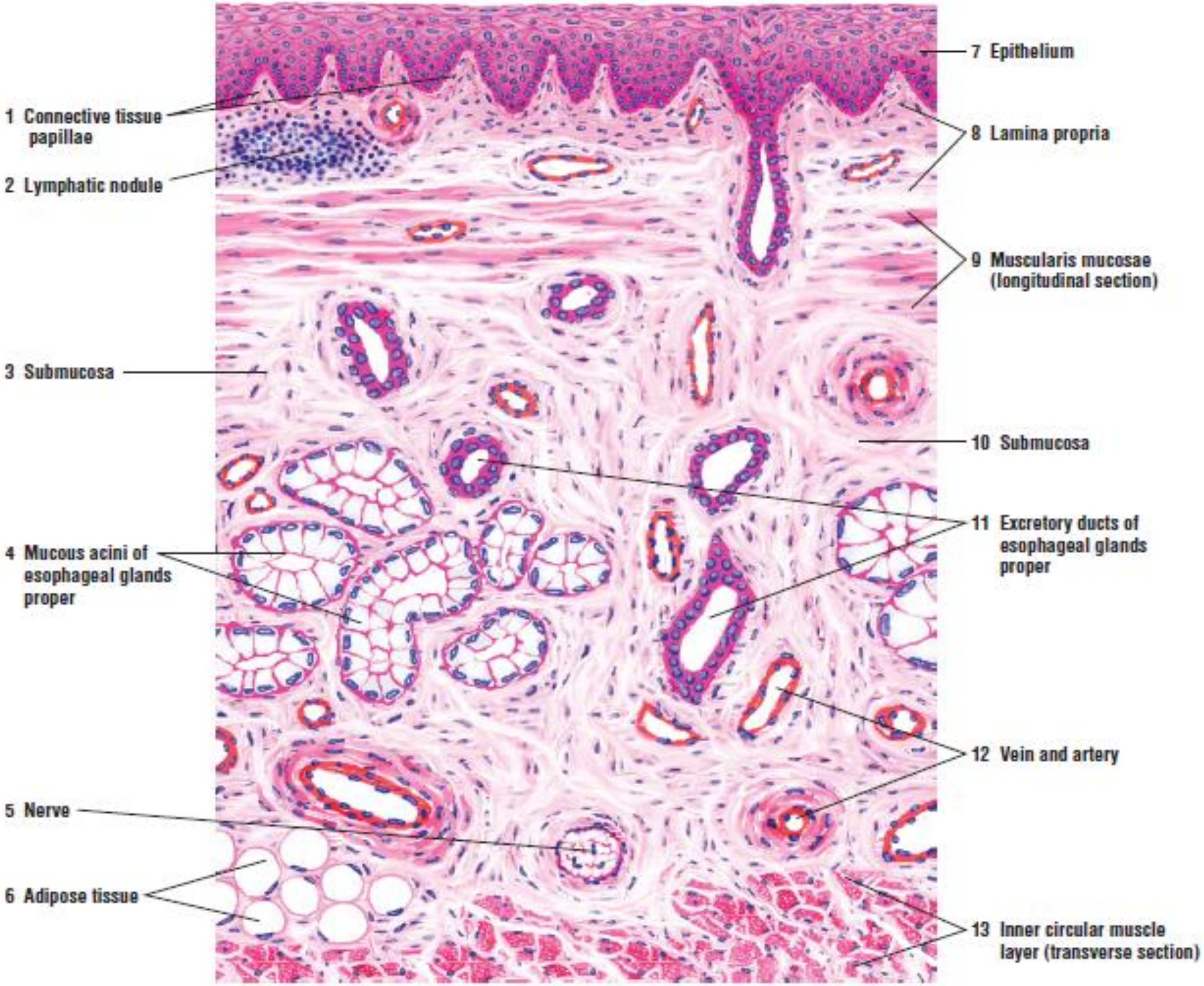


FIGURE 14.4 ■ Upper esophagus: mucosa and submucosa (longitudinal view). Stain: hematoxylin and eosin. Medium magnification.

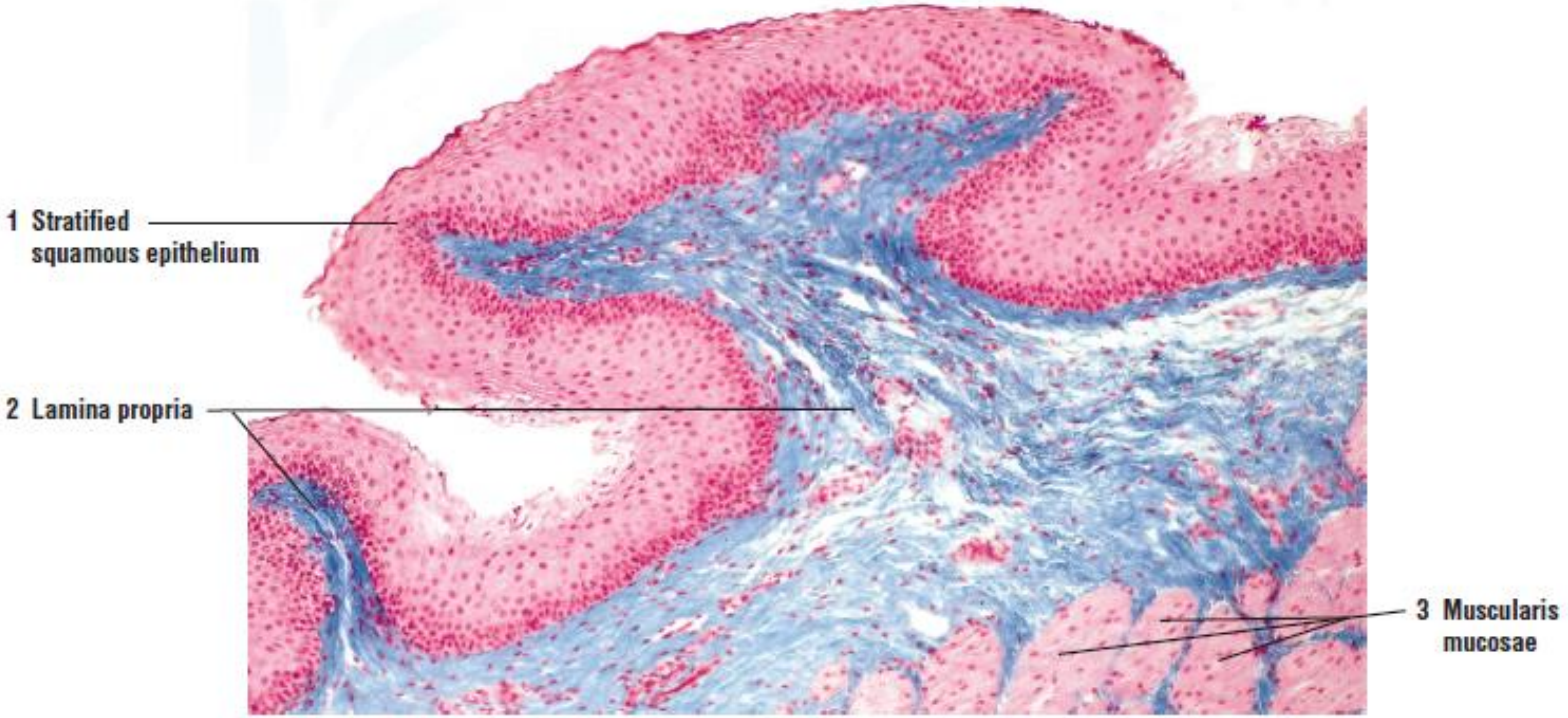
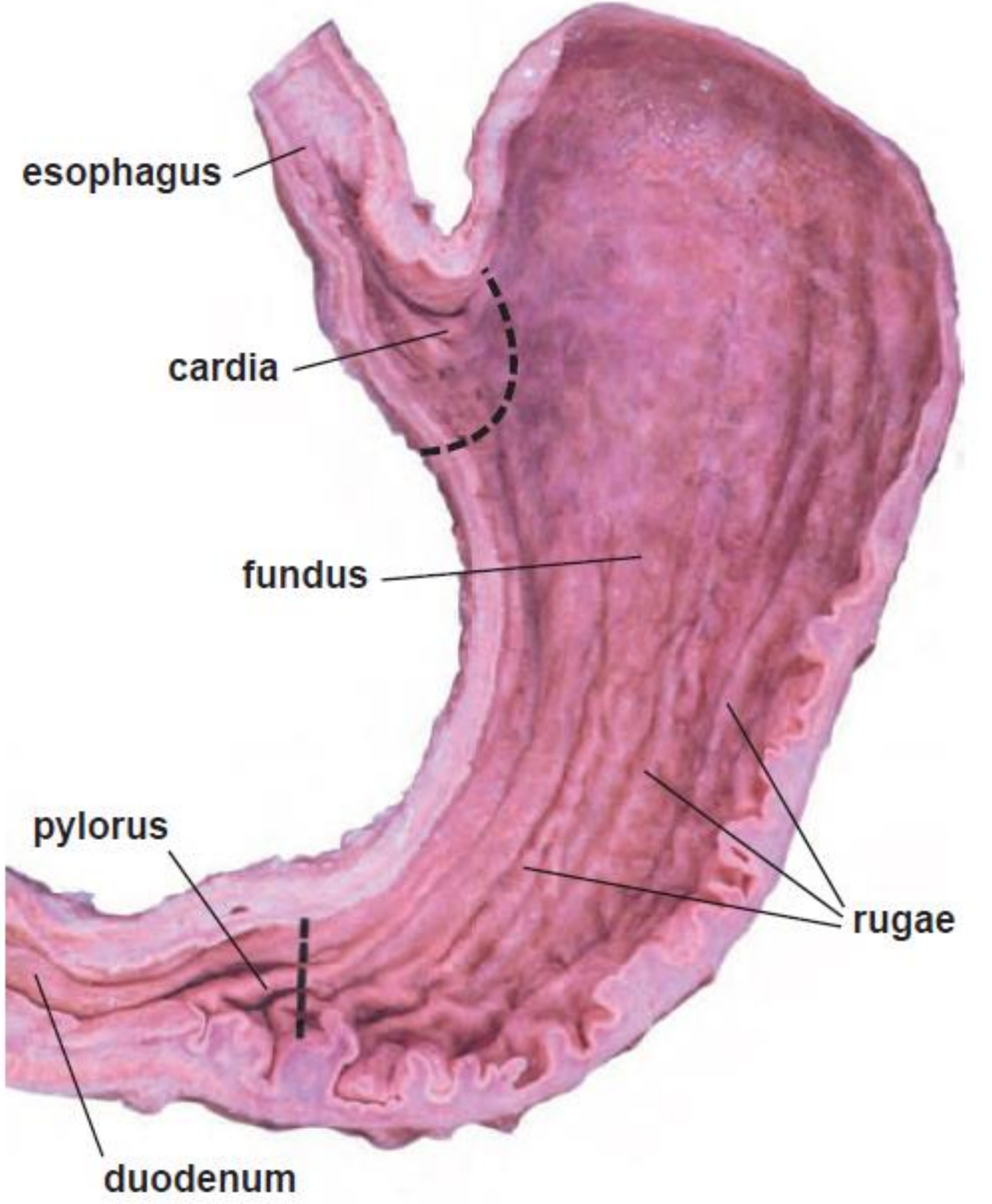
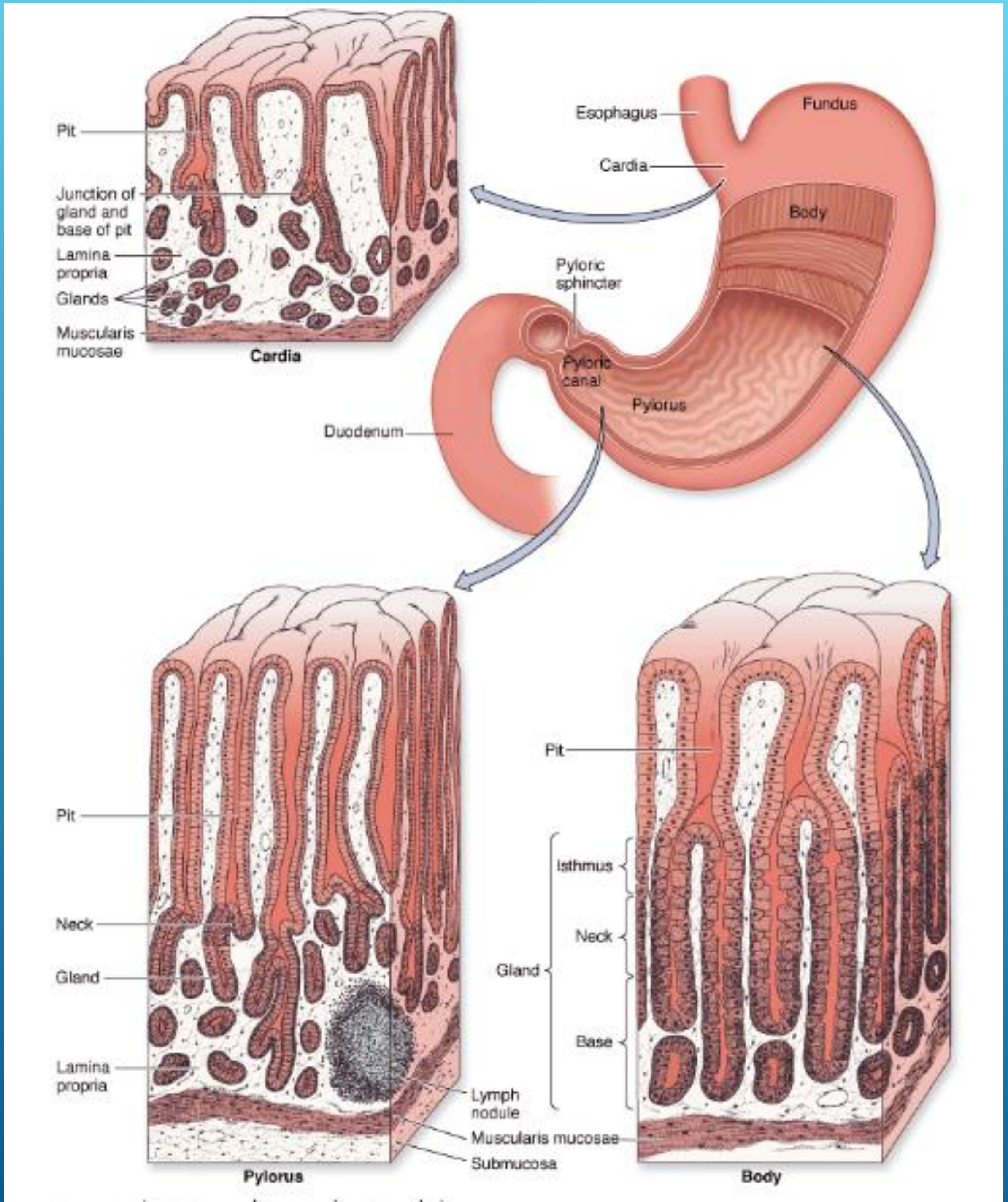
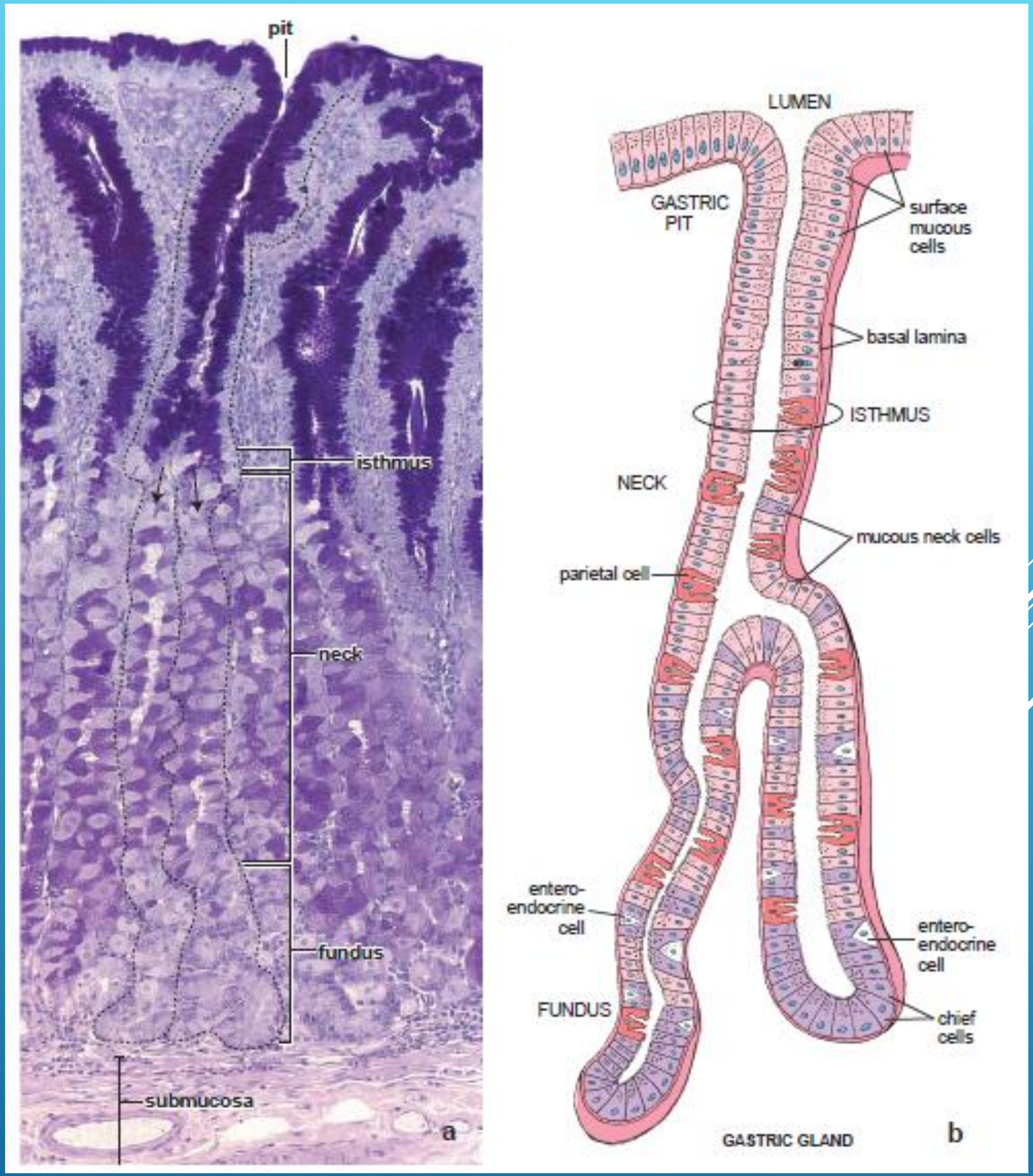


FIGURE 14.5 ■ Lower esophageal wall (transverse section). Stain: Mallory-Azan. ×30.

THE STOMACH


esophagus
cardia
fundus
pylorus
rugae
duodenum


Esophagus
Fundus
Cardia
Body
Pyloric sphincter
Pyloric canal
Pylorus
Duodenum
Pit
Junction of gland and base of pit
Lamina propria
Glands
Muscularis mucosae
Cardia
Pit
Neck
Gland
Lamina propria
Lymph nodule
Muscularis mucosae
Submucosa
Pylorus
Pit
Isthmus
Neck
Gland
Base
Body


pit
isthmus
neck
fundus
submucosa
a
LUMEN
GASTRIC PIT
surface mucous cells
basal lamina
ISTHMUS
NECK
mucous neck cells
parietal cell
entero-endocrine cell
entero-endocrine cell
FUNDUS
chief cells
GASTRIC GLAND
b

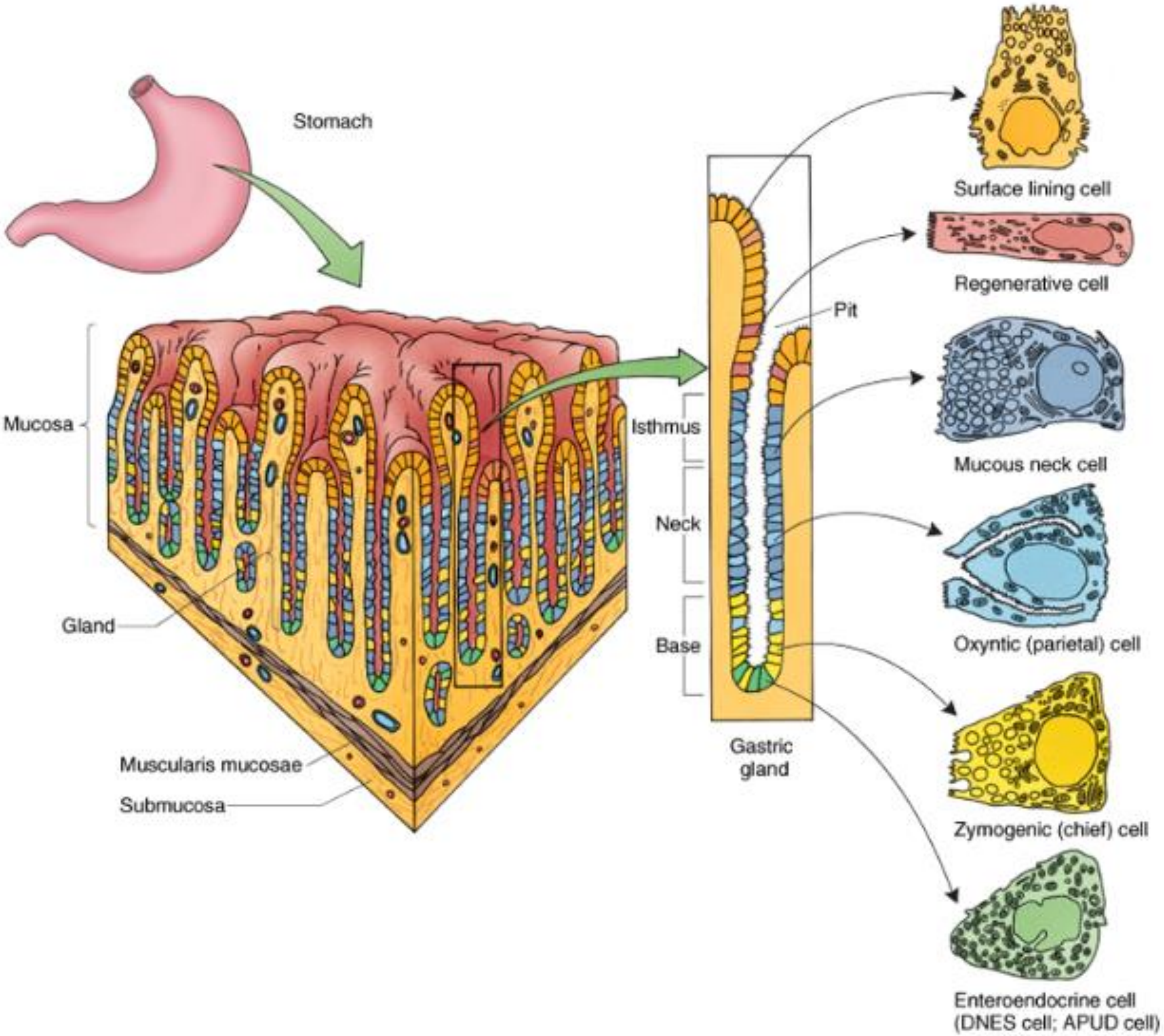


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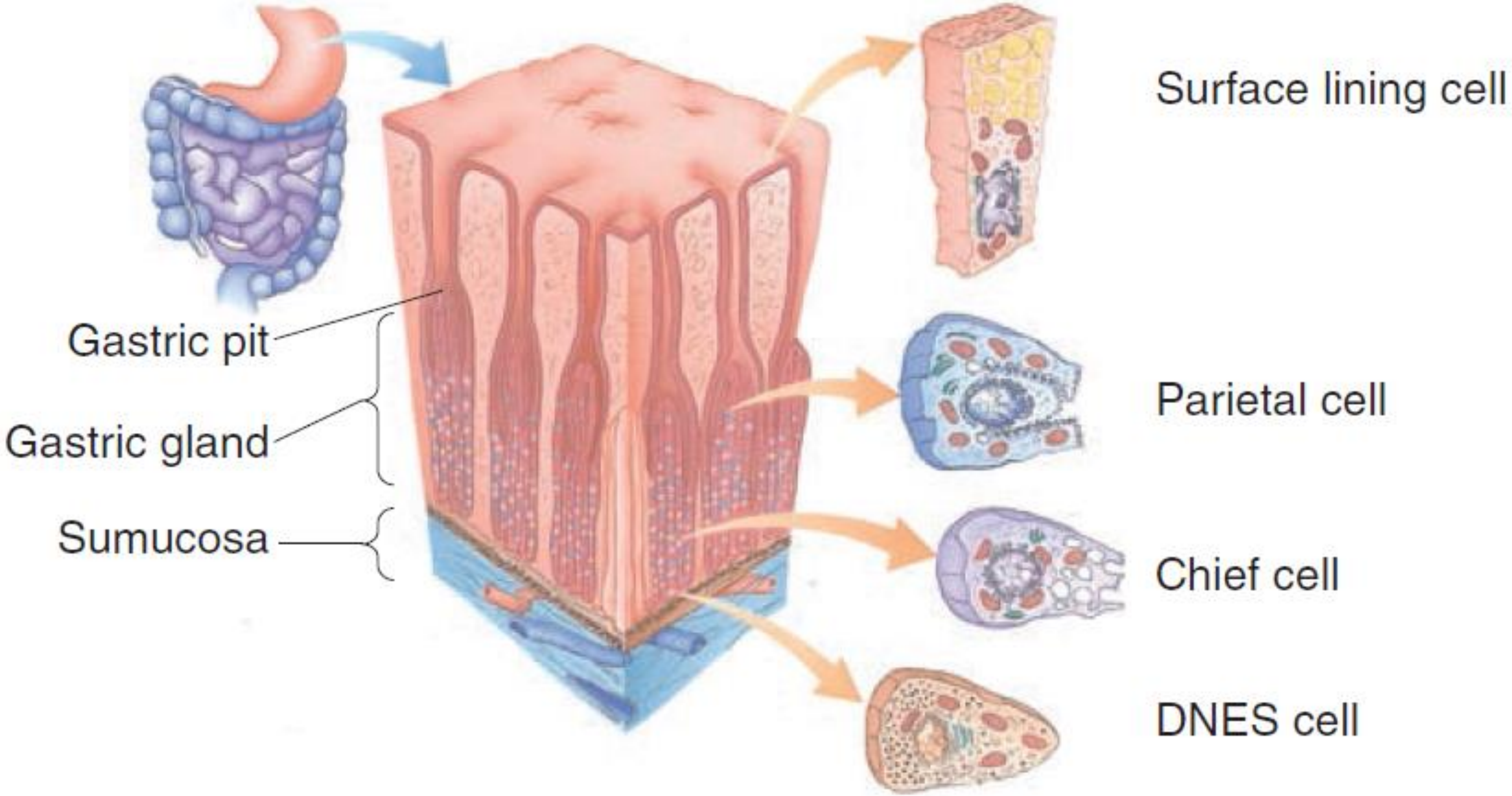
Figure 17-3 Cellular composition of the fundic stomach and fundic gland. The fundic glands open into the bottom of the gastric pits, and each gland is subdivided into an isthmus, a neck, and a base.



Stomach and cells

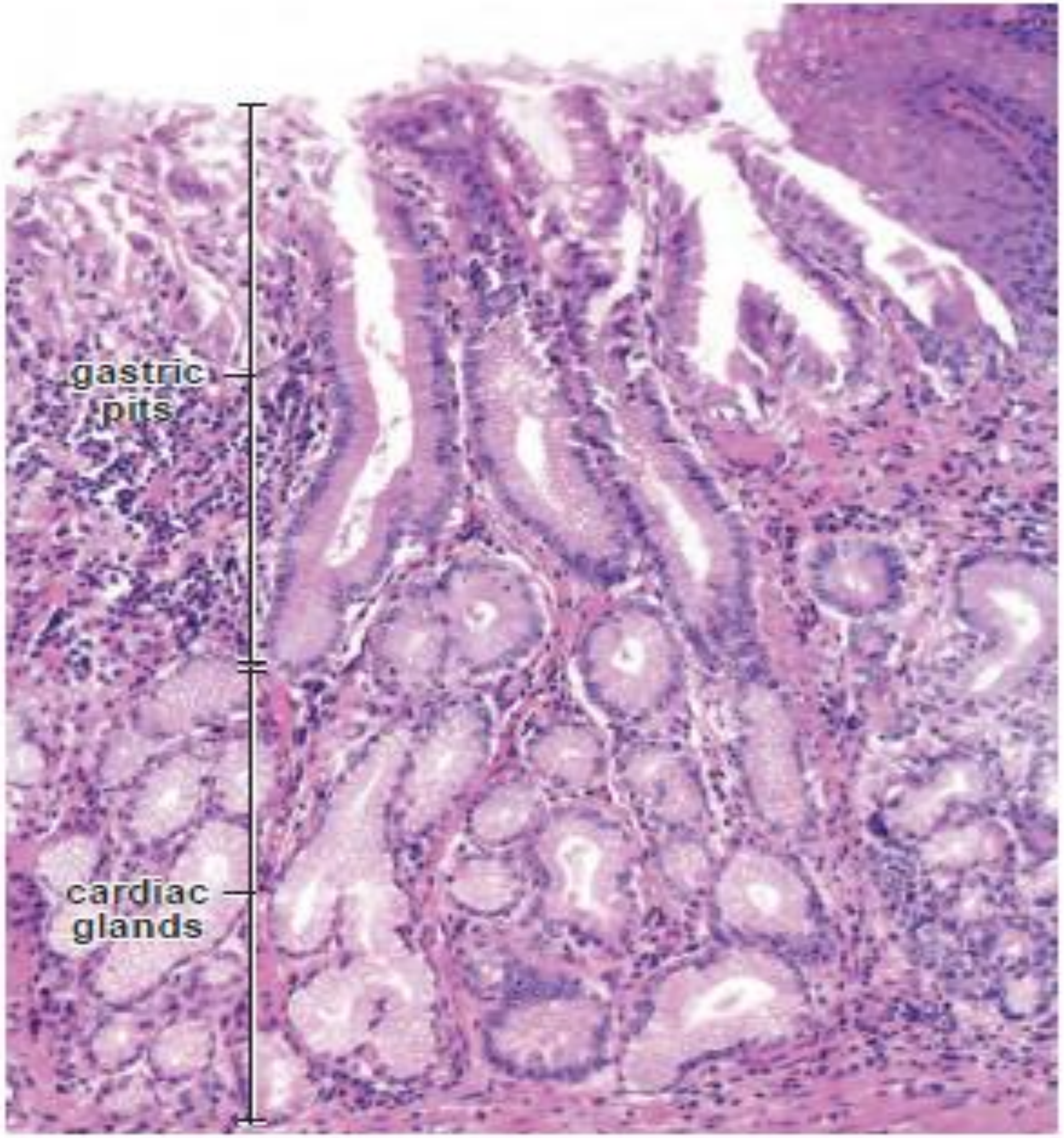
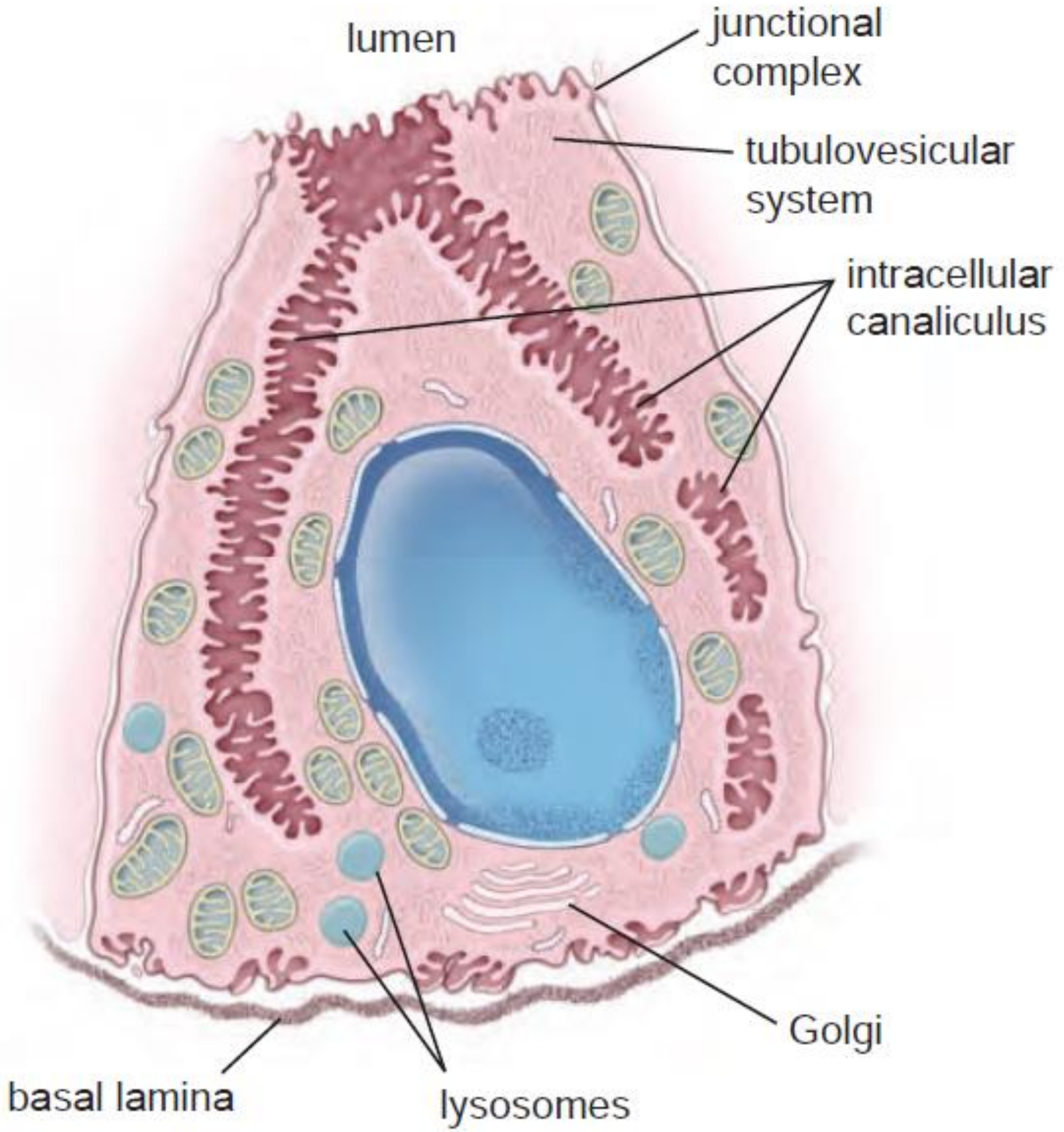
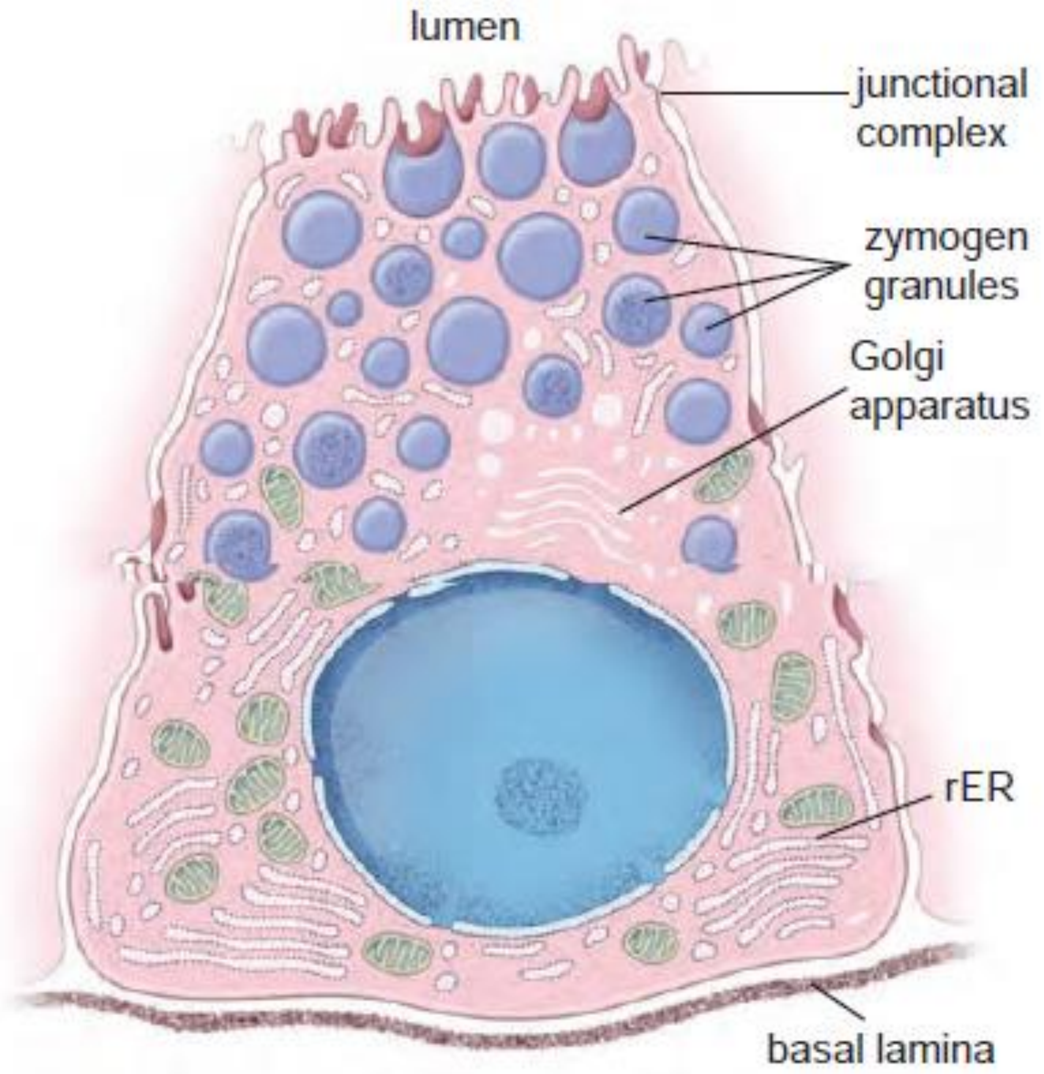


FIGURE 17.14 • Photomicrograph of cardiac glands.

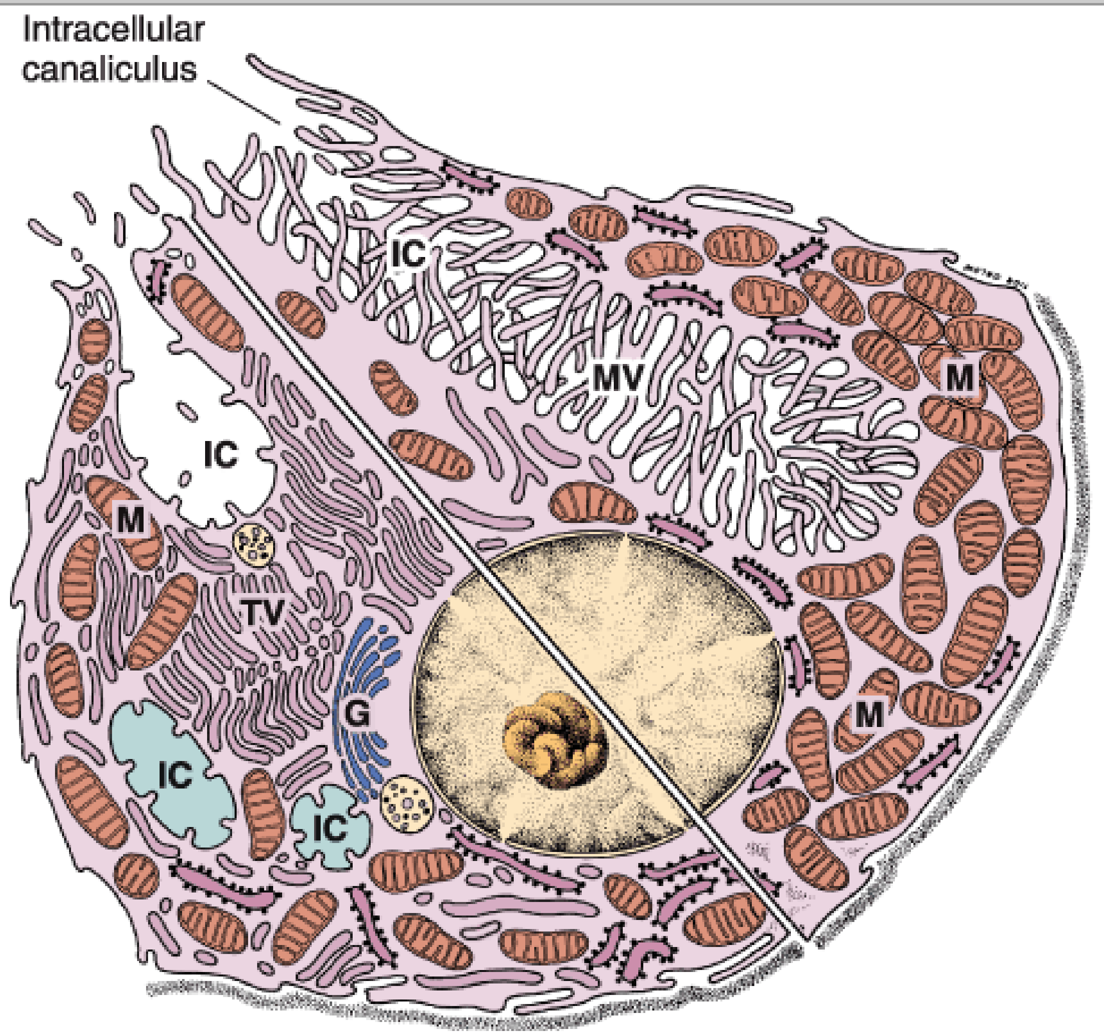
FIGURE 17.15 • Photomicrograph of pyloric glands.



PARIETAL CELL



CHIEF CELL



Composite diagram of a parietal cell, showing the ultrastructural differences between a resting cell **(left)** and an active cell **(right)**. Note that the tubulovesicles (TV) in the cytoplasm of the resting cell fuse to form microvilli (MV) that fill up the intracellular canaliculi (IC). G, Golgi complex; M, mitochondria. (Based on the work of Ito S, Schofield GC: Studies on the depletion and accumulation of microvilli and changes in the tubulovesicular compartment of mouse parietal cells in relation to gastric acid secretion. J Cell Biol 1974;63:364.)

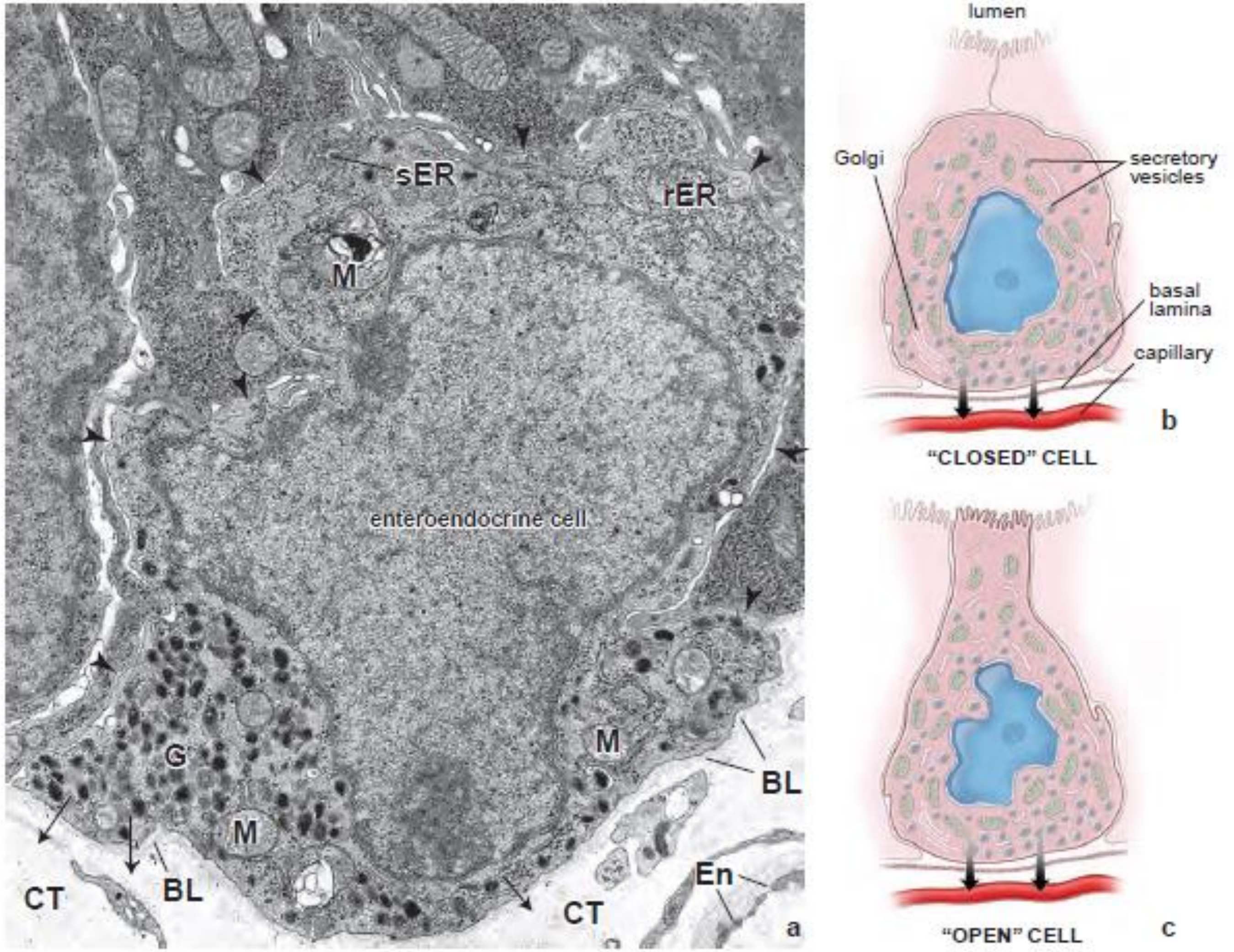
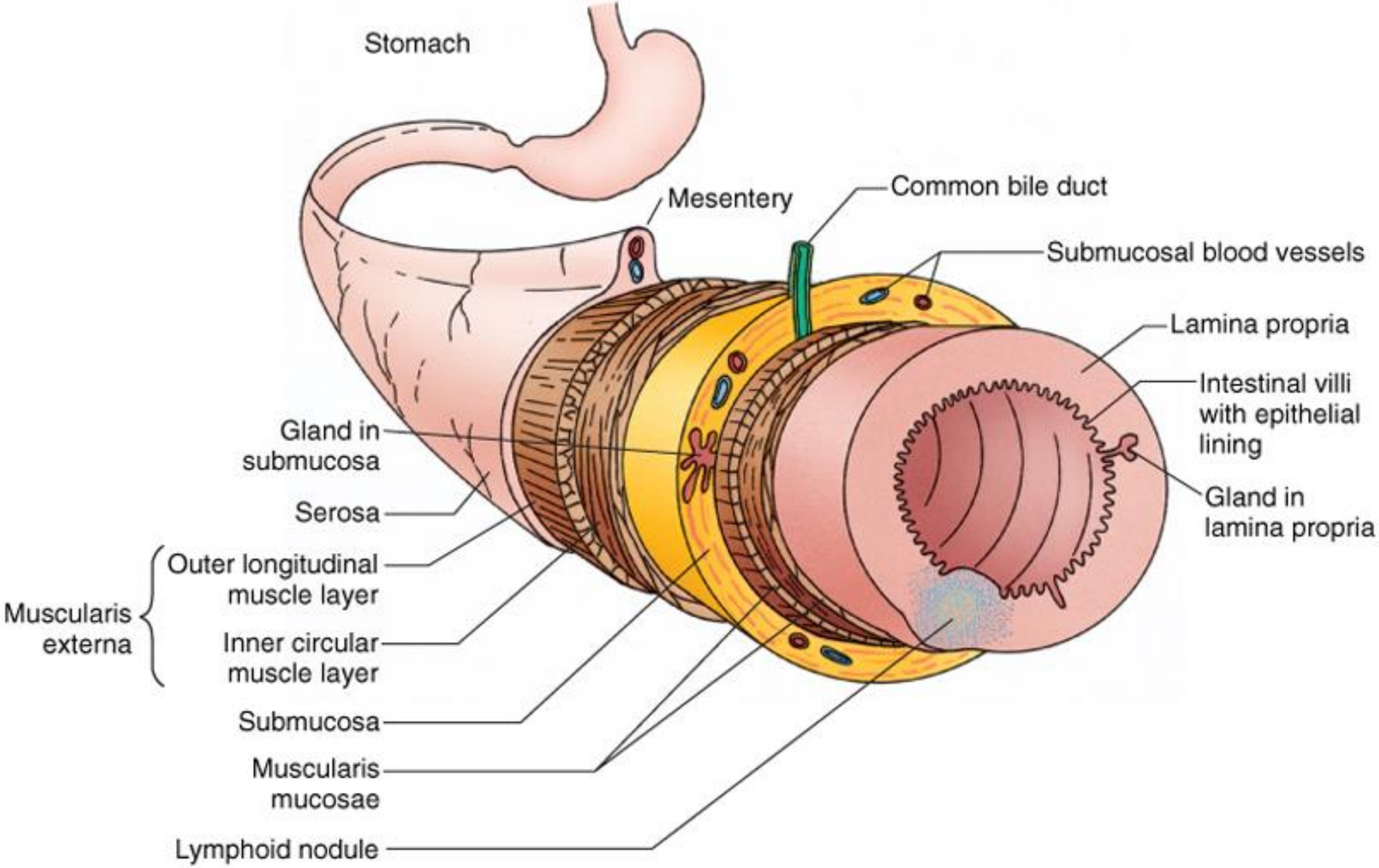
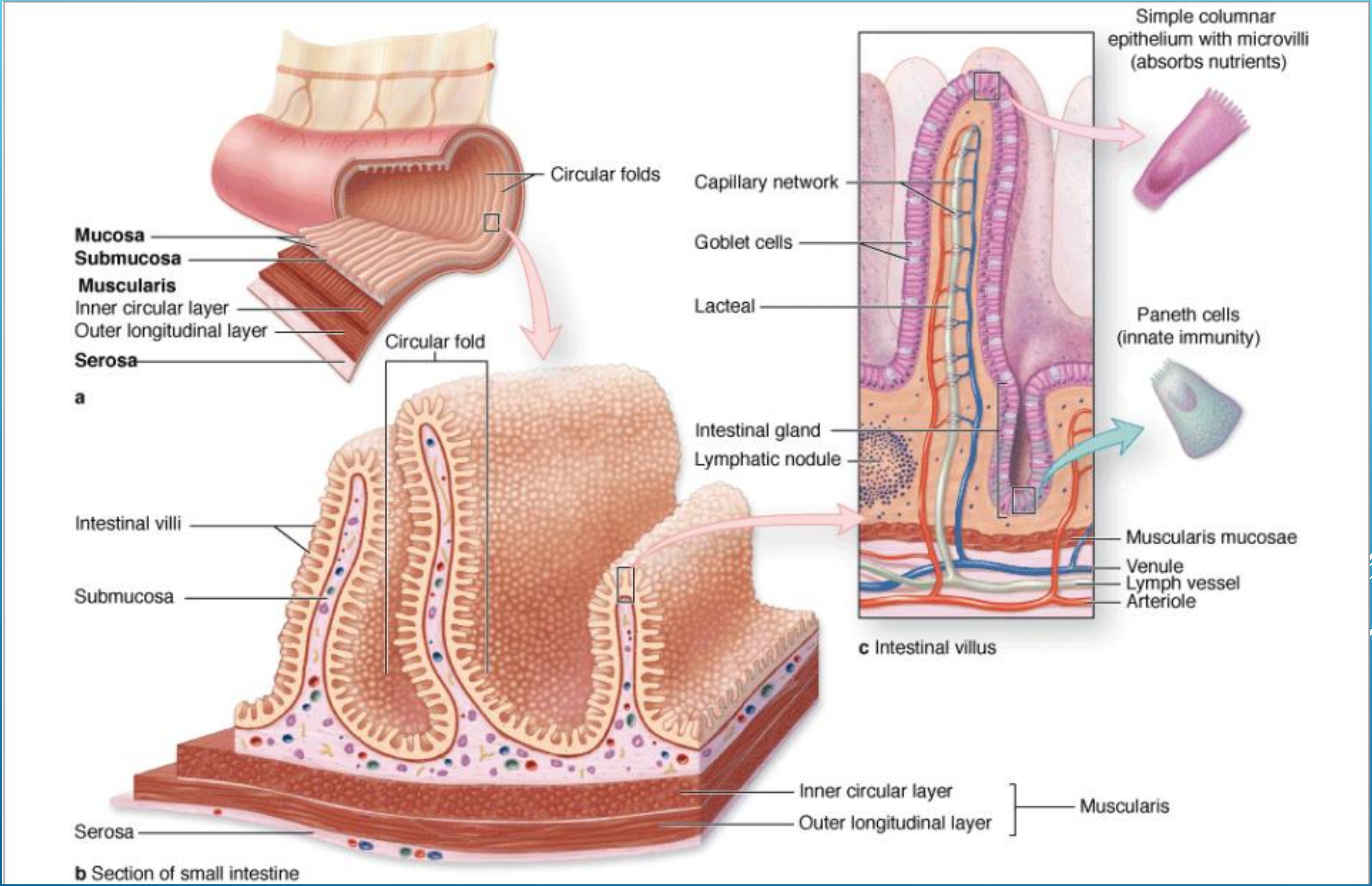


FIGURE 17.12 • Electron micrograph and diagrams of enteroendocrine cells. a. This electron micrograph shows an example of the "closed" enteroendocrine cell. *Arrowheads* mark the boundary between the enteroendocrine cell and the adjacent epithelial cells. At its base, the enteroendocrine cell rests on the basal lamina (*BL*). This cell does not extend to the epithelial or luminal surface. Numerous secretory vesicle (*G*) in the base of the cell are secreted in the direction of the *arrows* across the basal lamina and into the connective tissue (*CT*). *En,* endothelium of capillary; *M,* mitochondria; *rER,* rough endoplasmic reticulum; *sER,* smooth endoplasmic reticulum. **b.** This diagram of an enteroendocrine "closed" cell is drawn to show that it does not reach the epithelial surface. The secretory vesicles are regularly lost during routine preparation. Because of the absence of other distinctive organelles, the nucleus appears to be surrounded by a small amount of clear cytoplasm in H&E–stained sections. **c.** The enteroendocrine "open" extend to the epithelial surface. Microvilli on the apical surface of these cells possess taste receptors and are able to detect sweet, bitter, and umami sensations. These cells serve as chemoreceptor cells, which monitor an environment on the surface of the epithelium. They are involved in a regulation of gastrointestinal hormones secretion.

THE SMALL INTESTINE


Stomach
Mesentery
Common bile duct
Submucosal blood vessels
Lamina propria
Intestinal villi with epithelial lining
Gland in lamina propria
Gland in submucosa
Serosa
Muscularis externa
Outer longitudinal muscle layer
Inner circular muscle layer
Submucosa
Muscularis mucosae
Lymphoid nodule



Circular folds
Mucosa
Submucosa
Muscularis
Inner circular layer
Outer longitudinal layer
Serosa
a
Circular fold
Intestinal villi
Submucosa
Inner circular layer
Outer longitudinal layer
Muscularis
Serosa
b Section of small intestine
Simple columnar
epithelium with microvilli
(absorbs nutrients)
Capillary network
Goblet cells
Lacteal
Paneth cells
(innate immunity)
Intestinal gland
Lymphatic nodule
Muscularis mucosae
Venule
Lymph vessel
Arteriole
c Intestinal villus

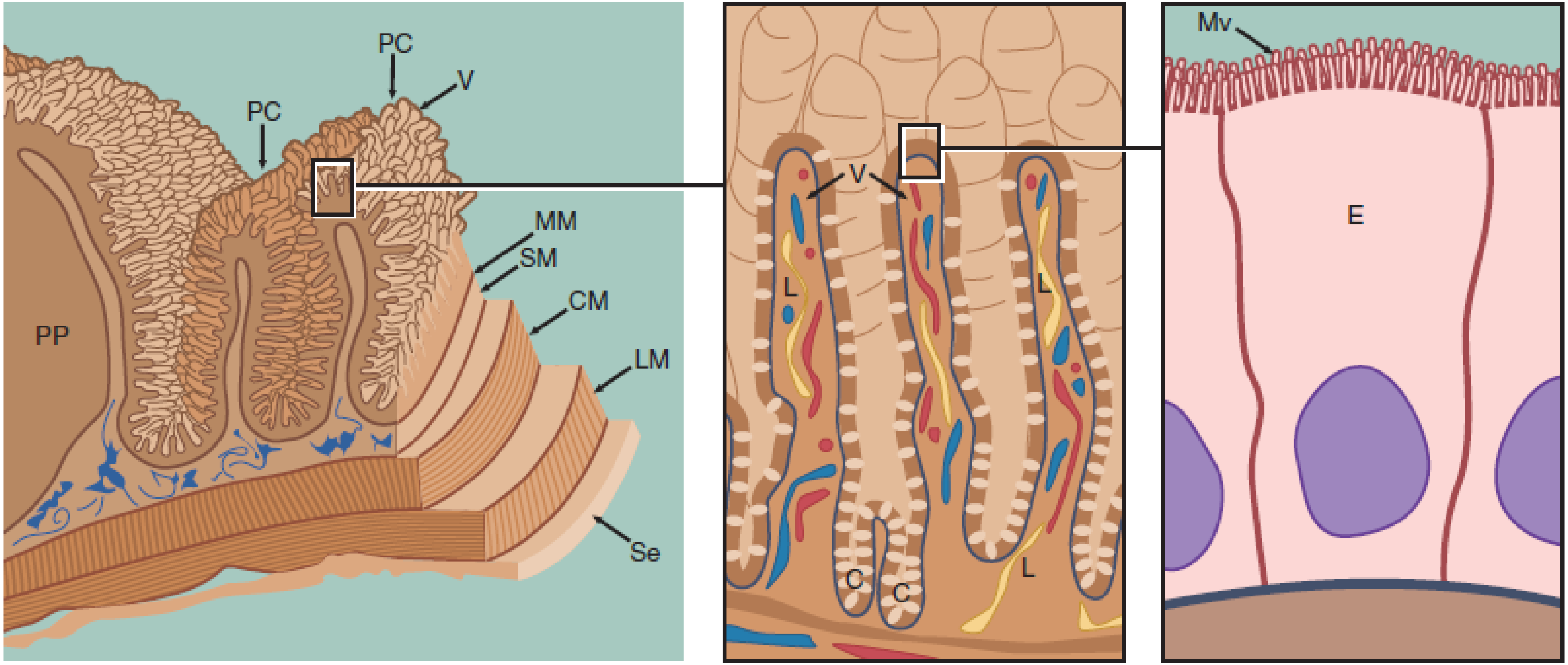
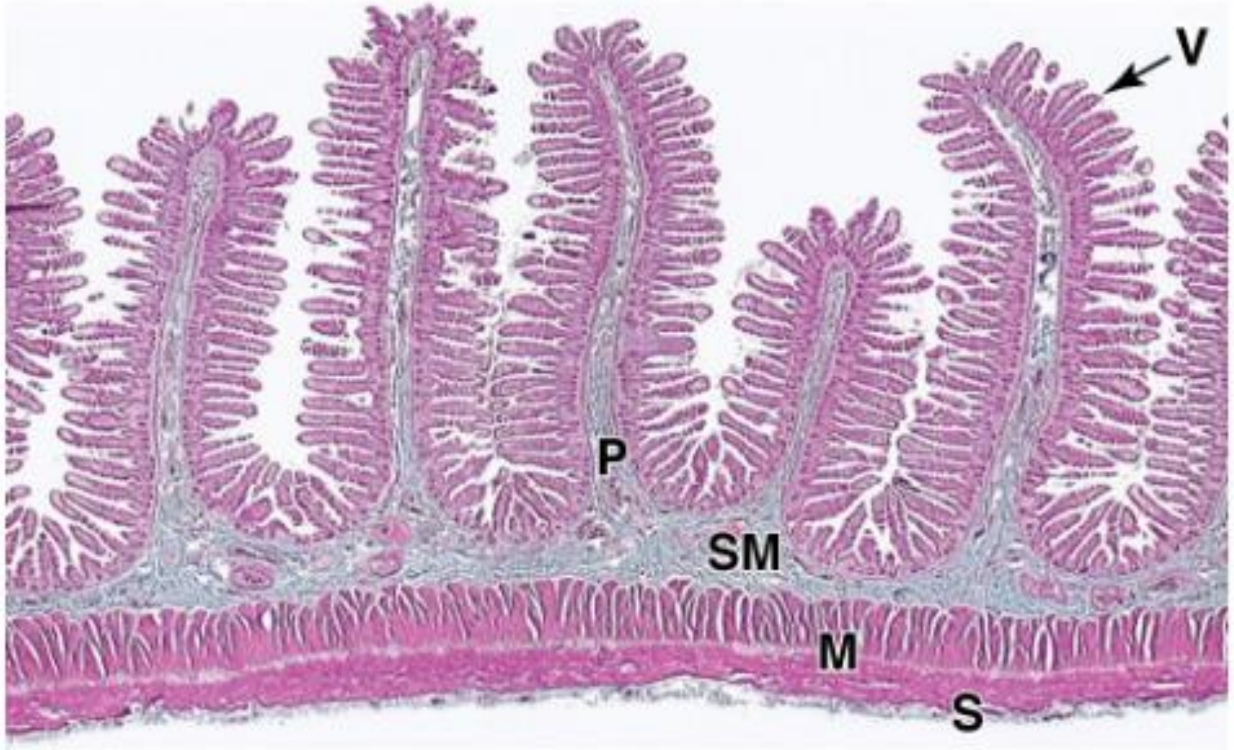


FIG. 14.18 Small intestine



Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: http://www.accessmedicine.com

Plicae ciculares (folds) of the jejunum.

The mucosa and submucosa (SM) of the small intestine form distinct projecting folds called plicae (P), which encircle or spiral around the inner circumference and are best developed in the jejunum. On each fold the mucosa forms a dense covering of projecting structures called villi (V). In this longitudinal section the two layers of the muscularis (M) are clearly distinguished. The inner layer has smooth muscle encircling the submucosa; the outer layer runs lengthwise just inside the serosa (S), the gut's outer layer. This arrangement of smooth muscle provides for strong peristaltic movement of the gut's contents. X12. H&E.

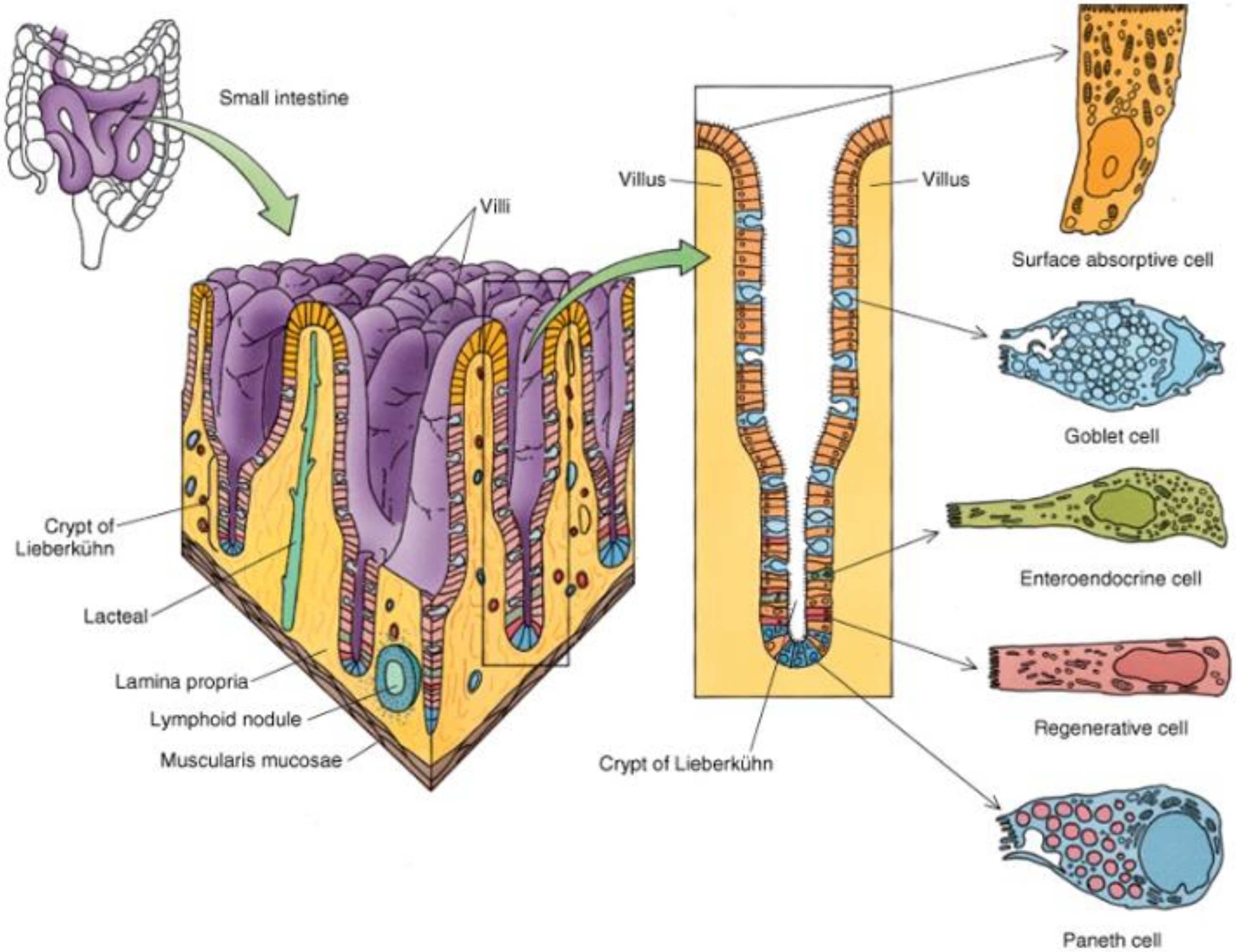


Figure 17-13 Mucosa, villi, crypts of Lieberkühn, and component cells of the small intestine. Note that the crypts of Lieberkühn open into the intervillar spaces. There is a solitary lymphoid nodule in the lamina propria.

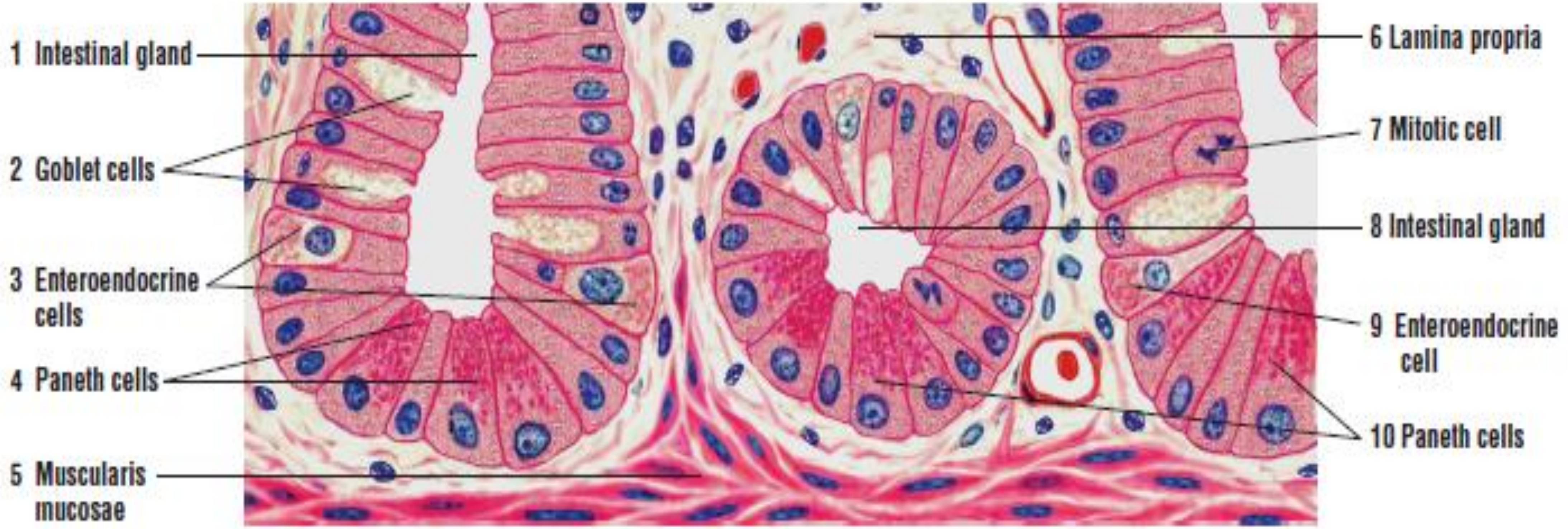
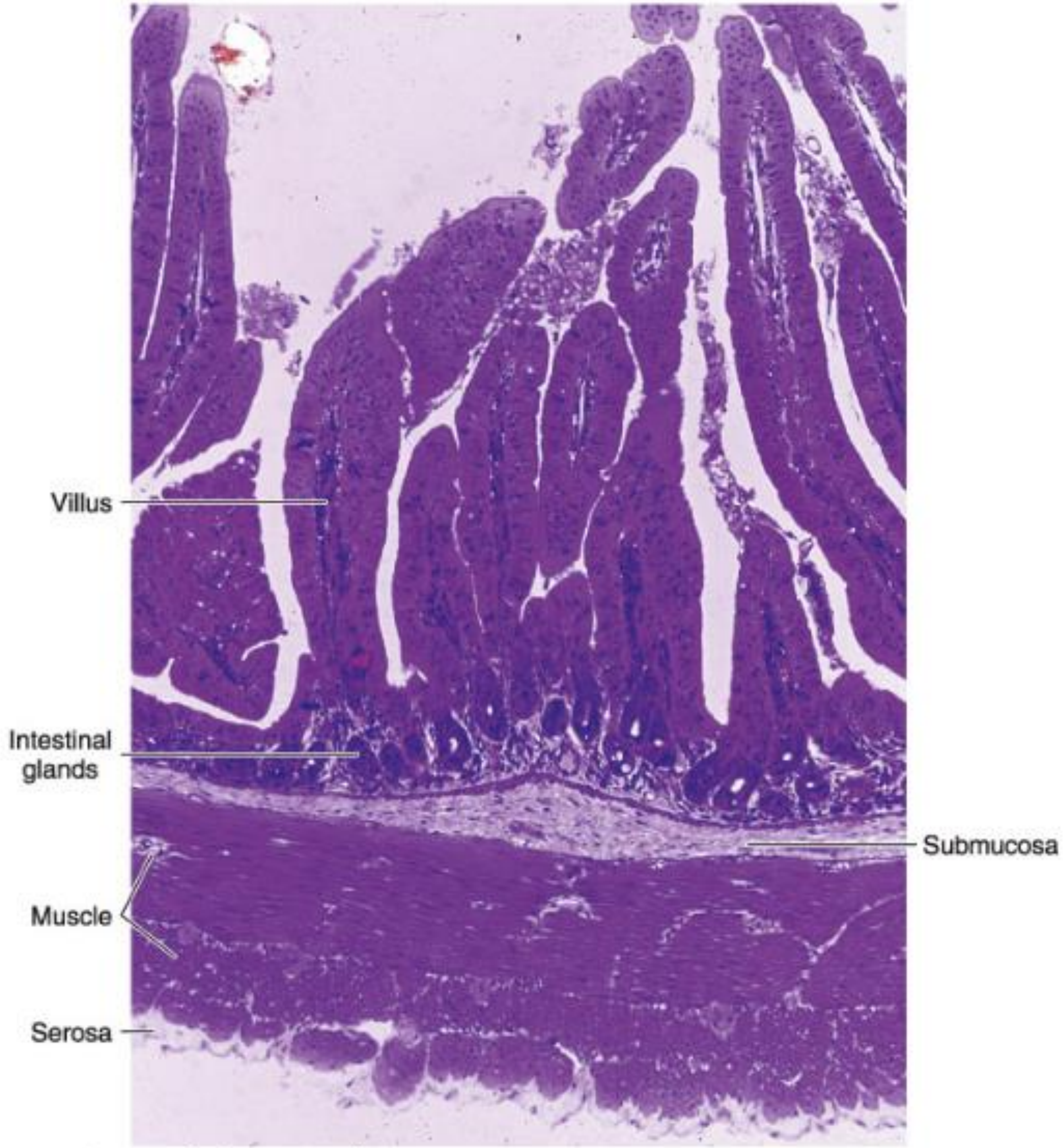
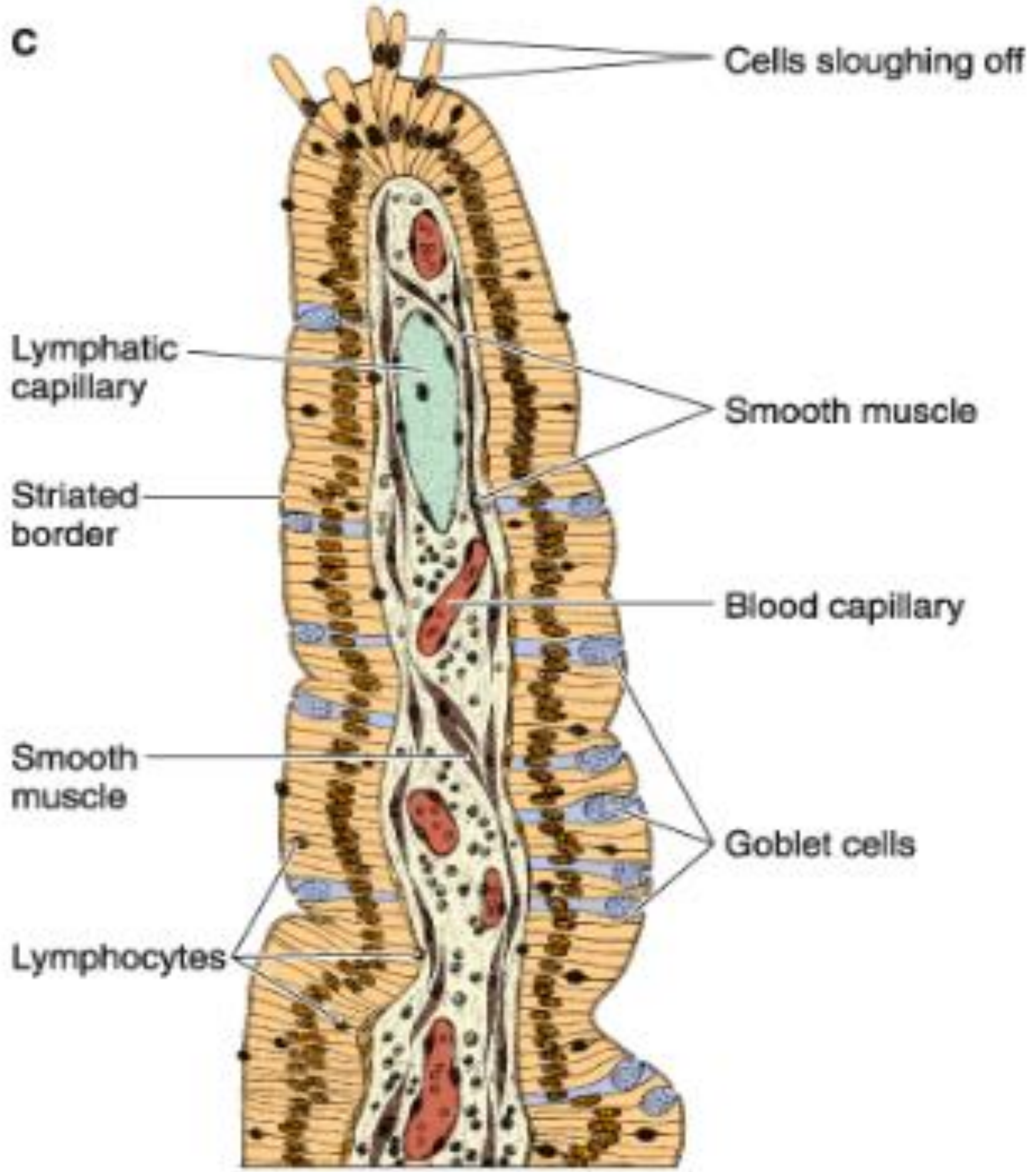


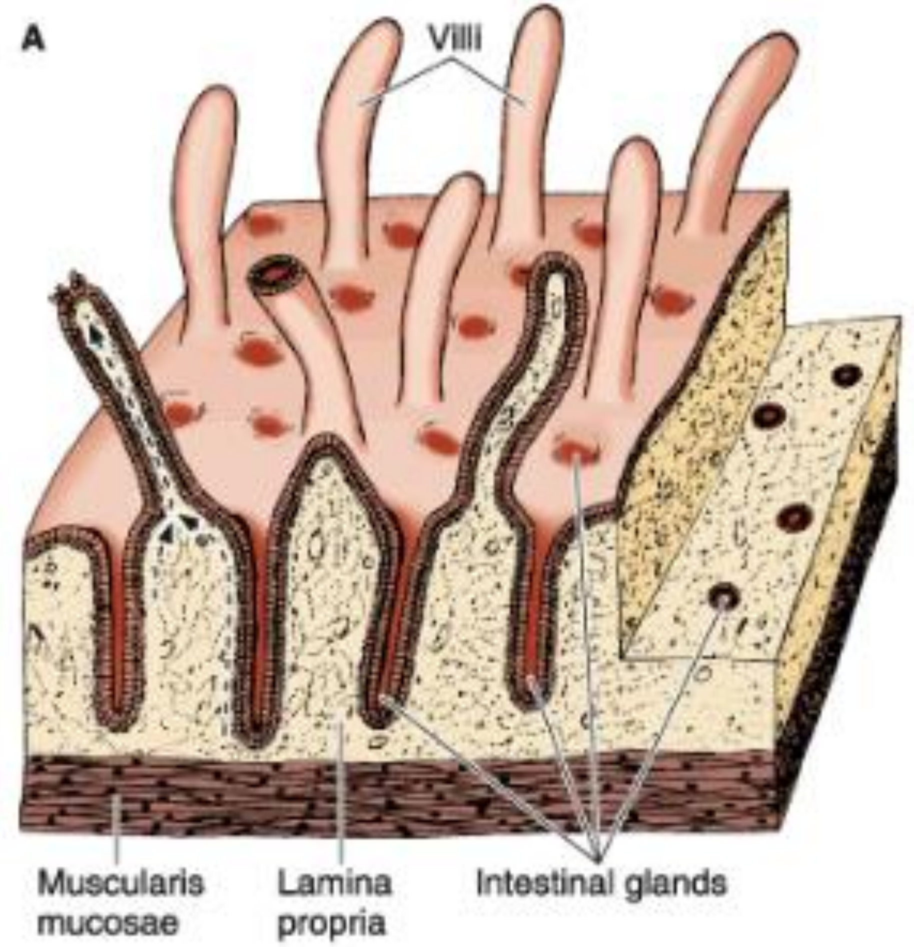
FIGURE 15.4 ■ Intestinal glands with Paneth cells and enteroendocrine cells. Stain: hematoxylin and eosin. High magnification.

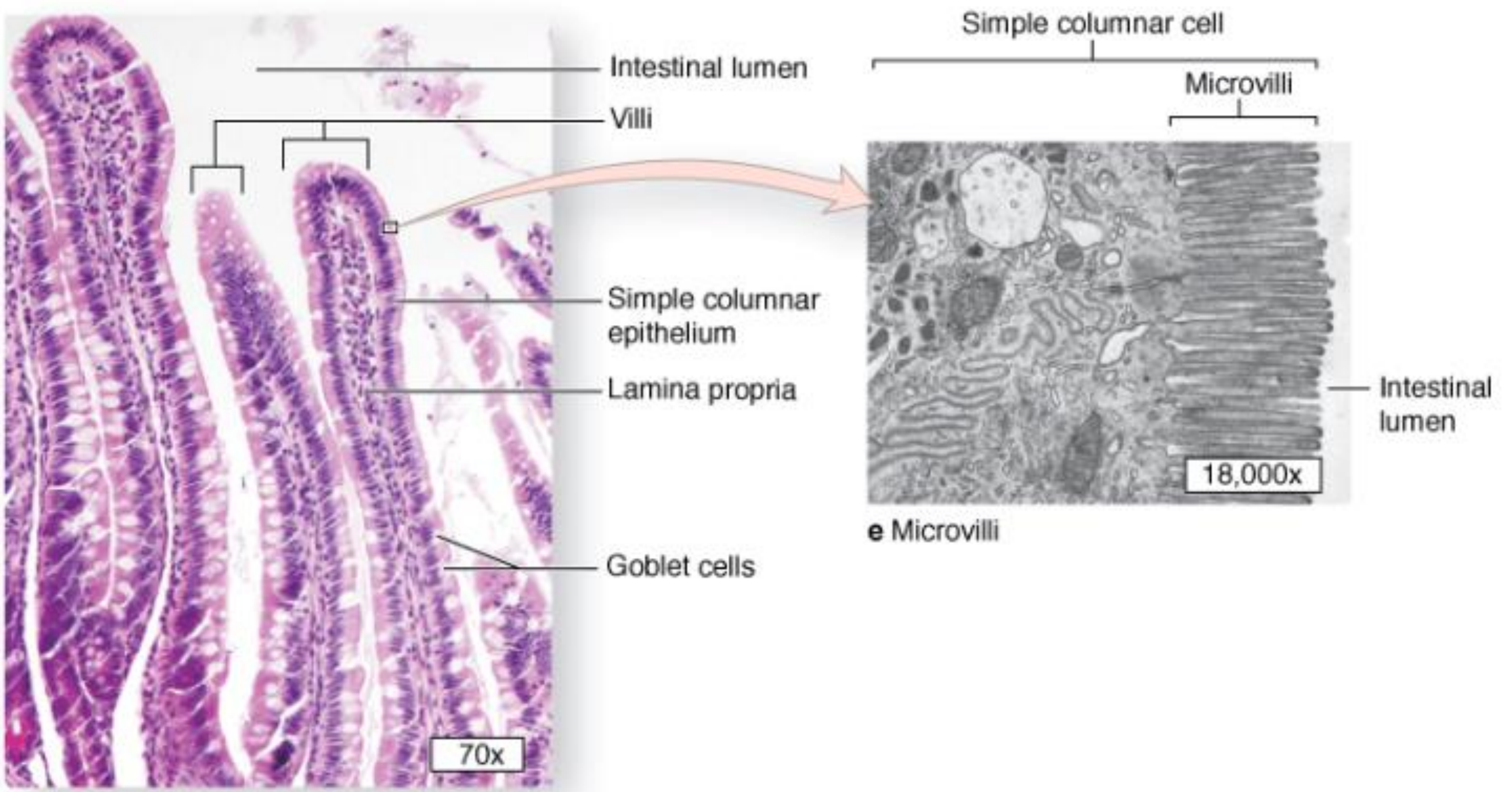


Photomicrograph of the small intestine. Note the villi, intestinal glands, submucosa, muscle layers, and serosa. PT stain. Low magnification.



intestinal villus





d Intestinal villi

e Microvilli

Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: http://www.accessmedicine.com

Absorptive surface of the small intestine.

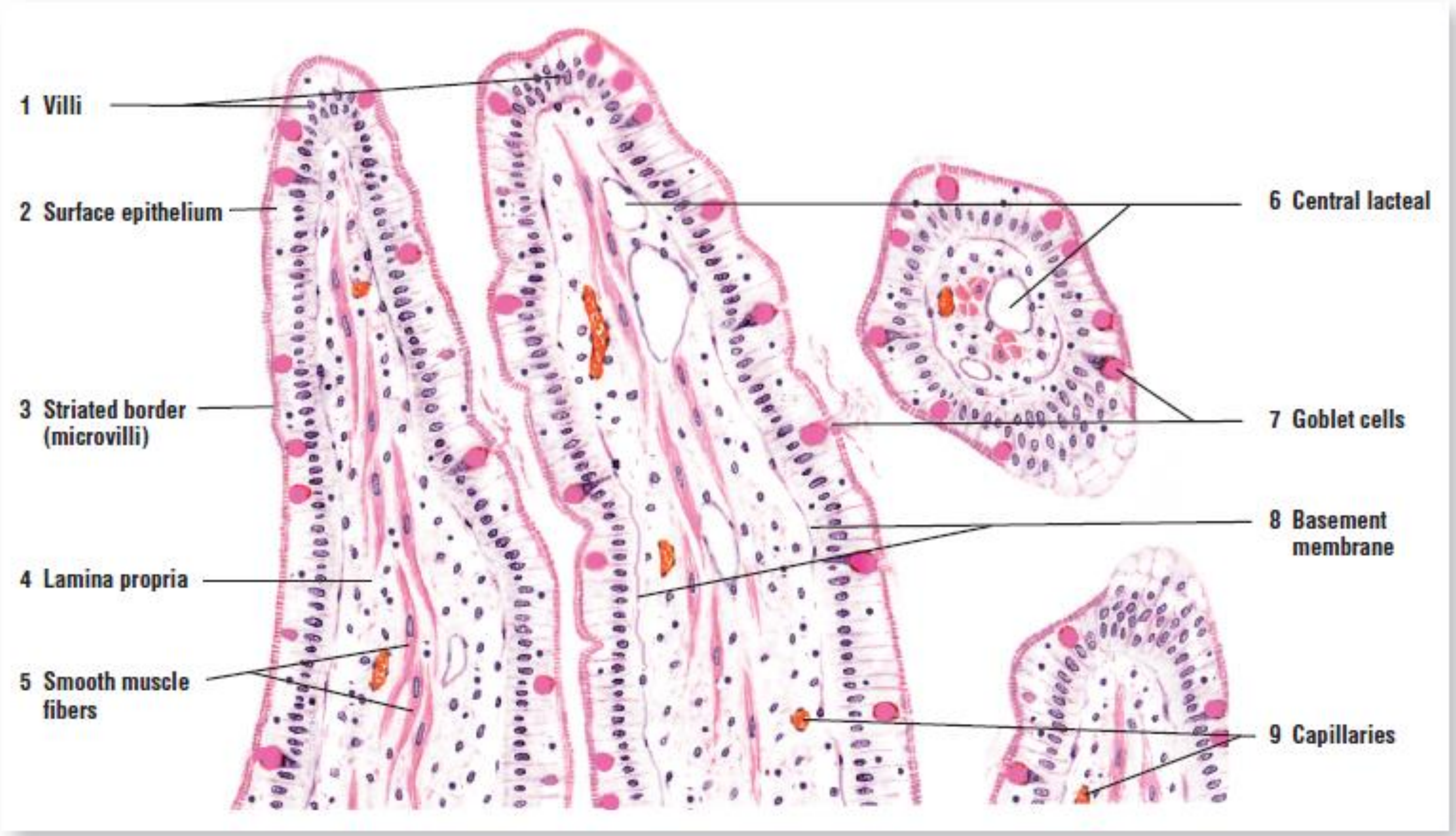


FIGURE 15.7 ■ Small intestine: villi (longitudinal and transverse sections). Stain: periodic acid-Schiff. Medium magnification.

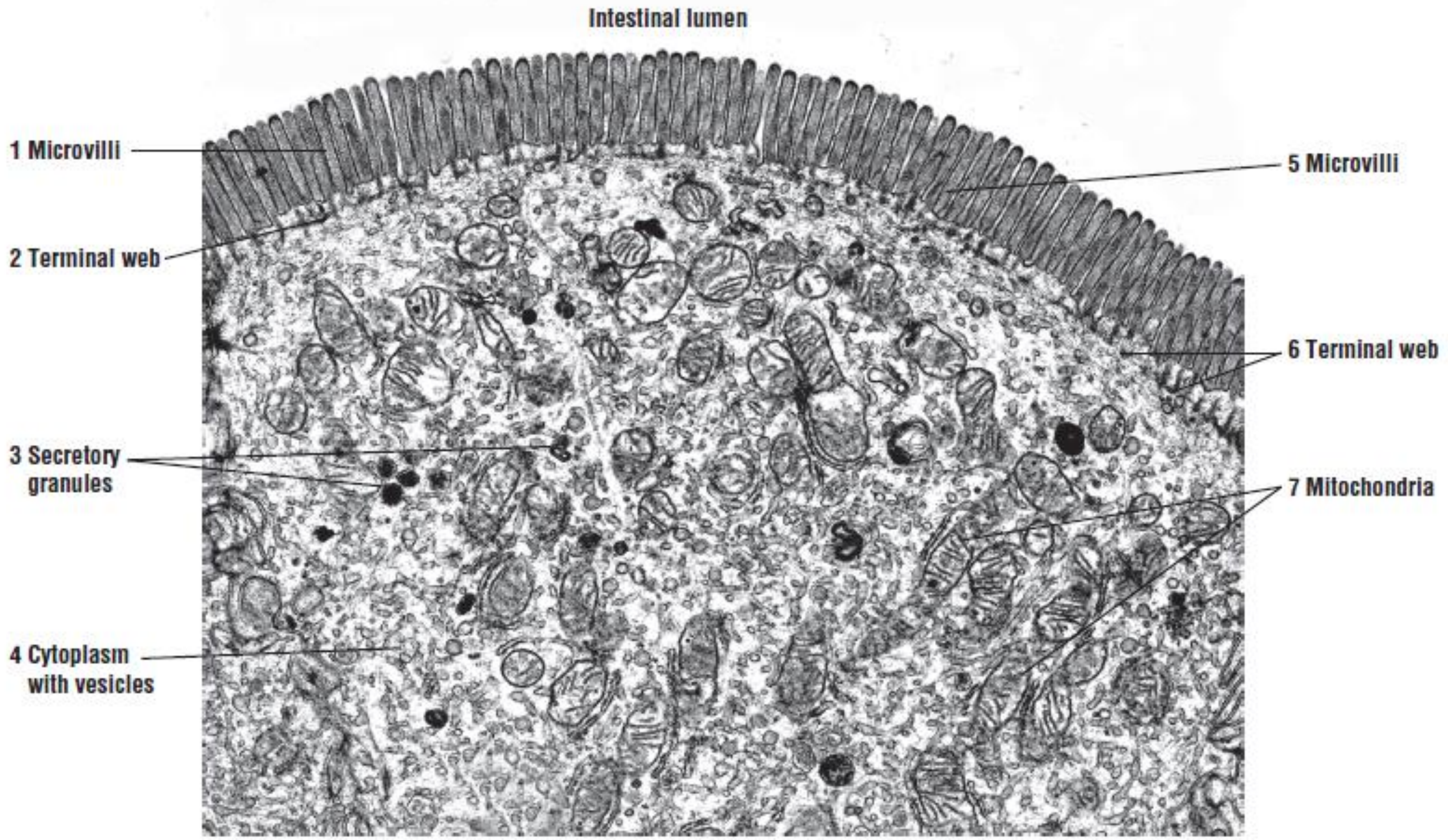
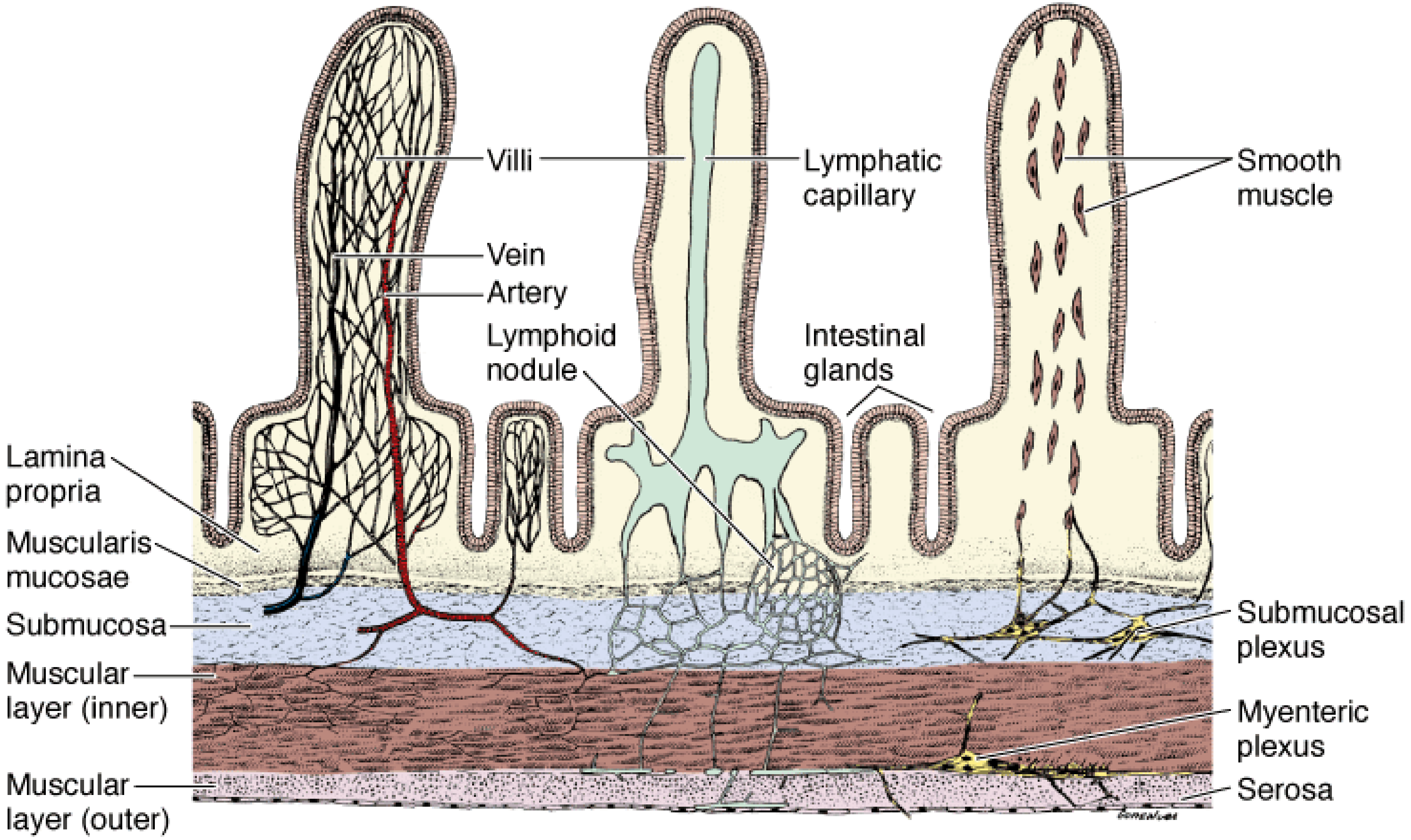
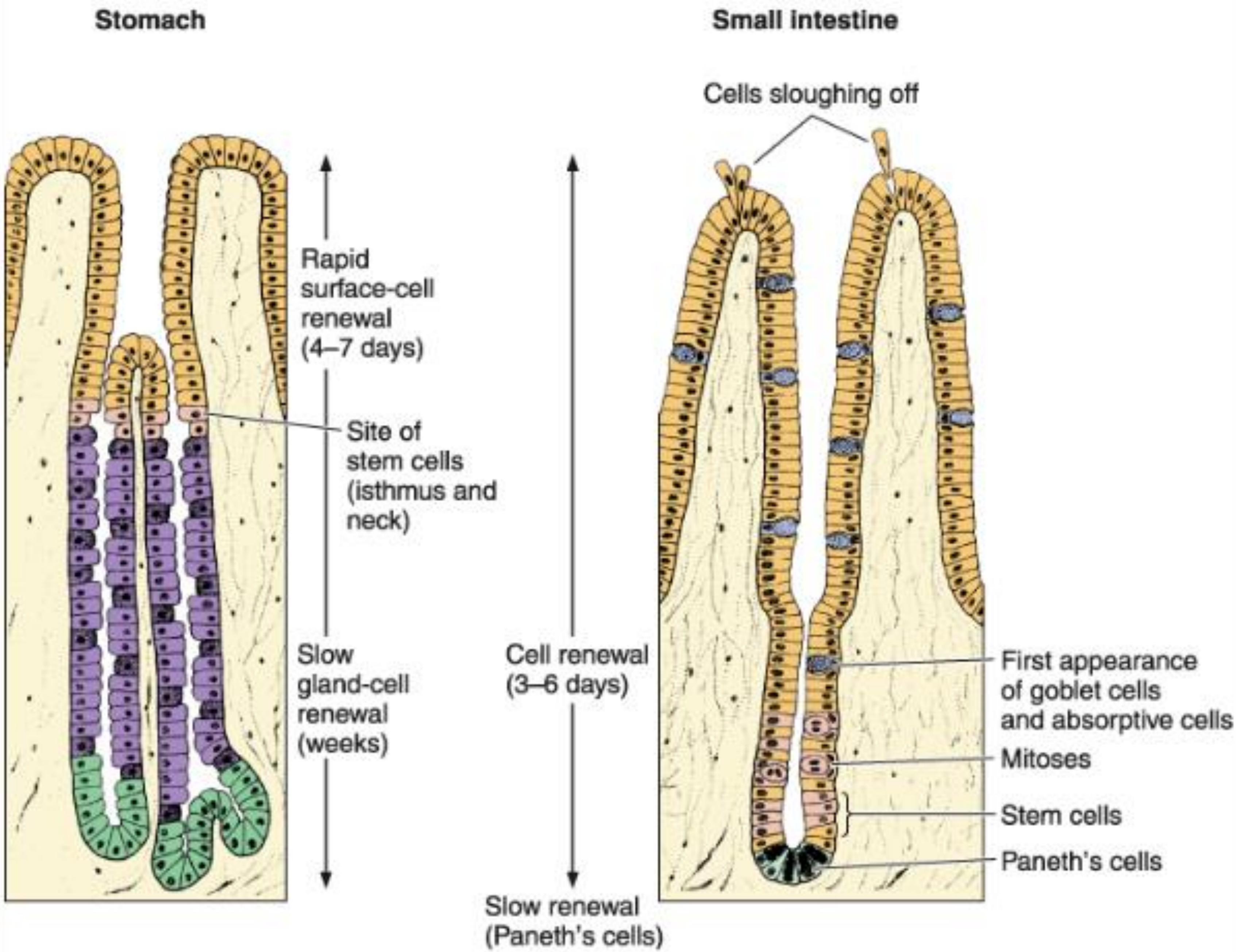


FIGURE 15.8 ■ Ultrastructure of microvilli in an absorptive cell in the small intestine. Courtesy of Dr. Rex A. Hess, Professor Emeritus, Comparative Biosciences, College of Veterinary Medicine, University of Illinois, Urbana, Illinois. ×6,150.

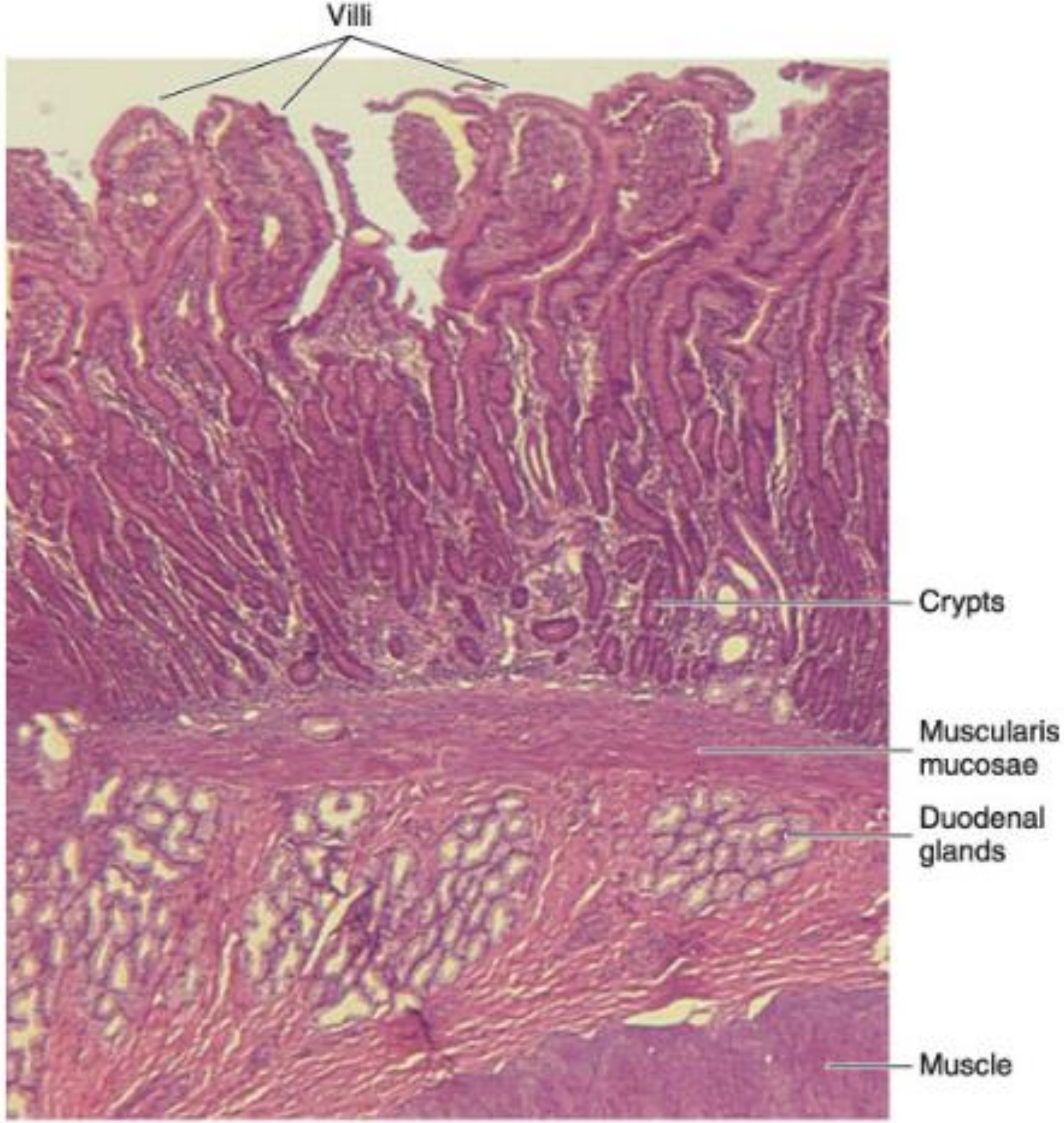


Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: http://www.accessmedicine.com

Microvasculature, lymphatics, and muscle in villi.



Regeneration of the epithelial lining of the stomach and small intestine. Note differences in the location of stem cells.



Photomicrograph of the duodenum, showing villi and duodenal glands in the submucosa. H&E stain. Low magnification. (Courtesy of MF Santos.)

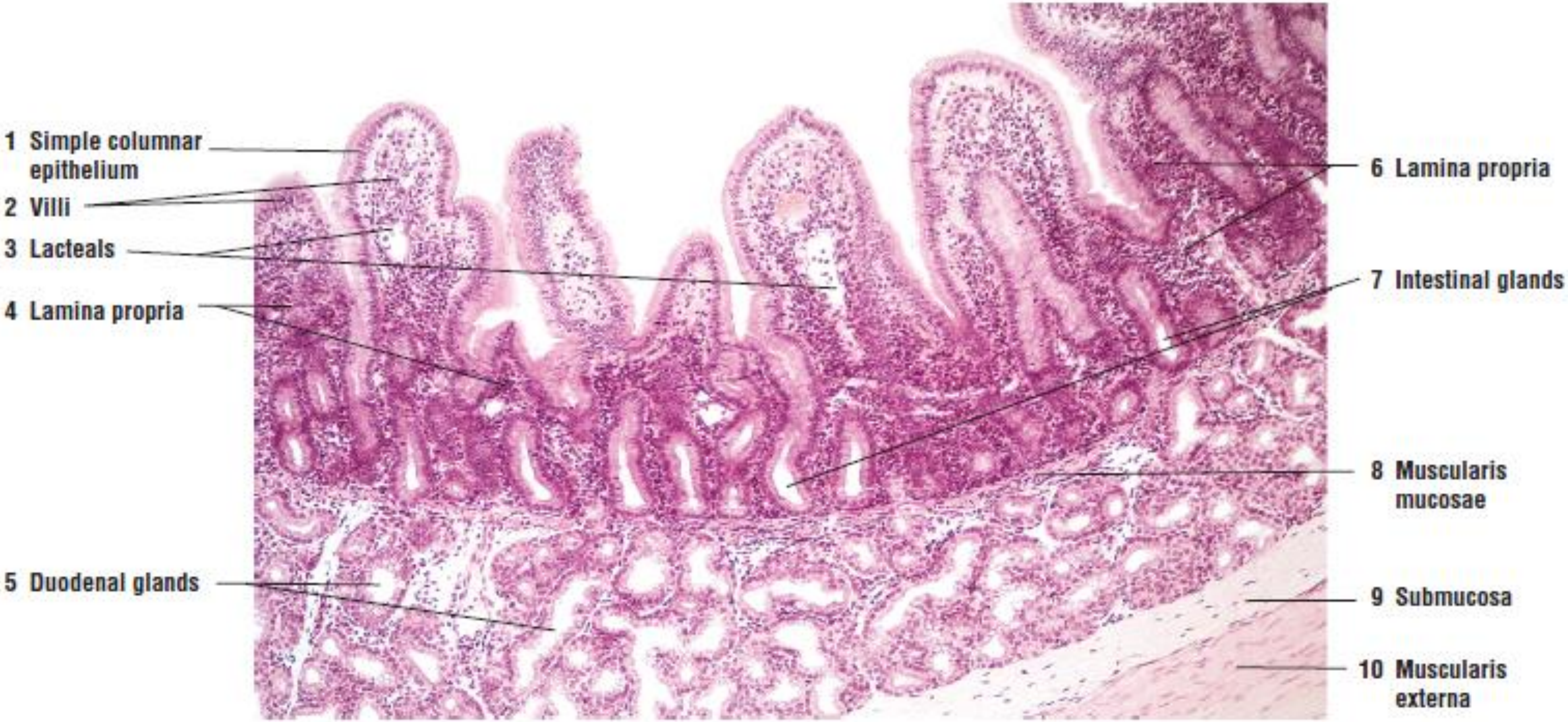


FIGURE 15.2 ■ Small intestine: duodenum (transverse section). Stain: hematoxylin and eosin. ×25.

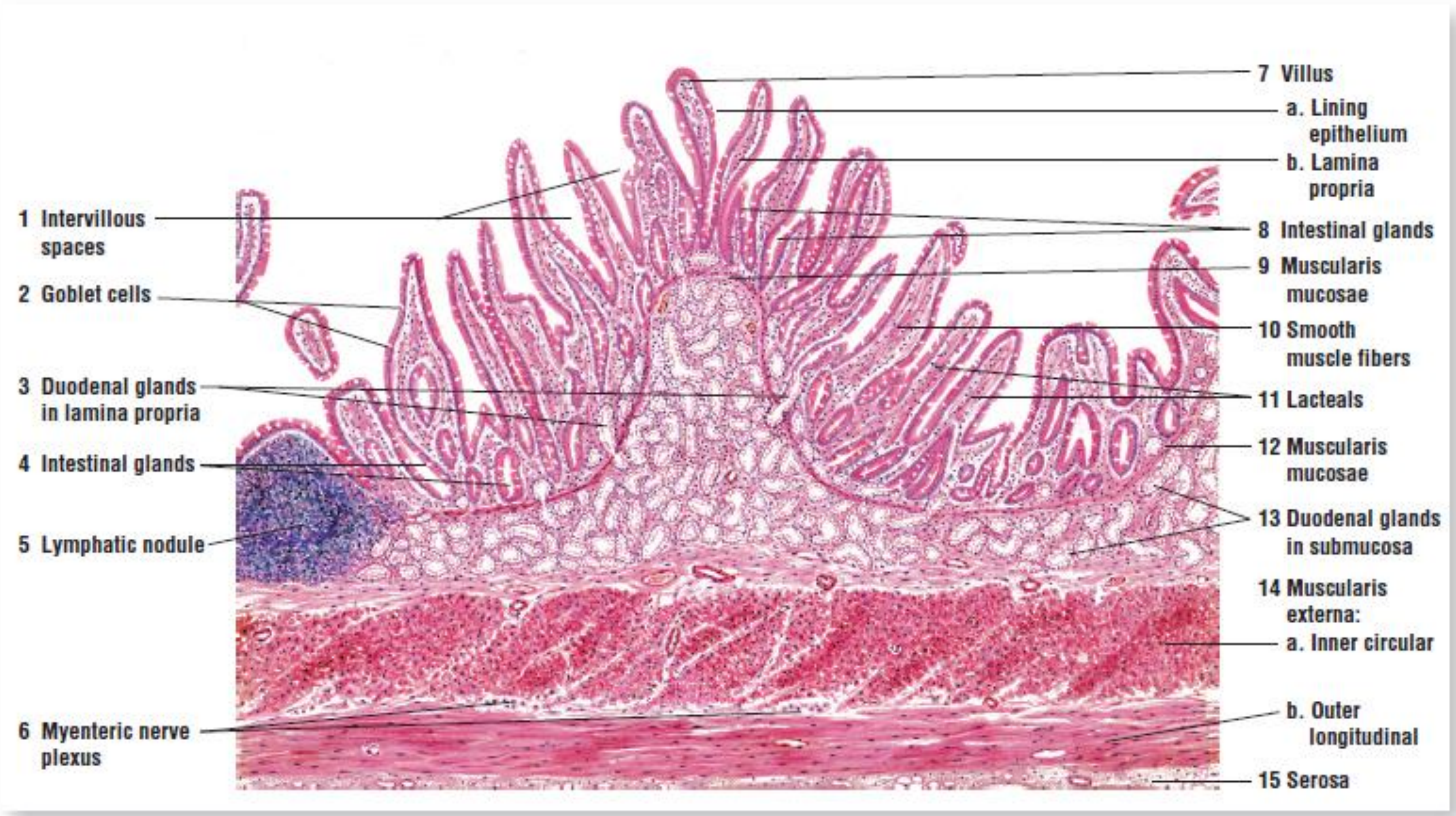


FIGURE 15.1 ■ Small intestine: duodenum (longitudinal section). Stain: hematoxylin and eosin. Low magnification.

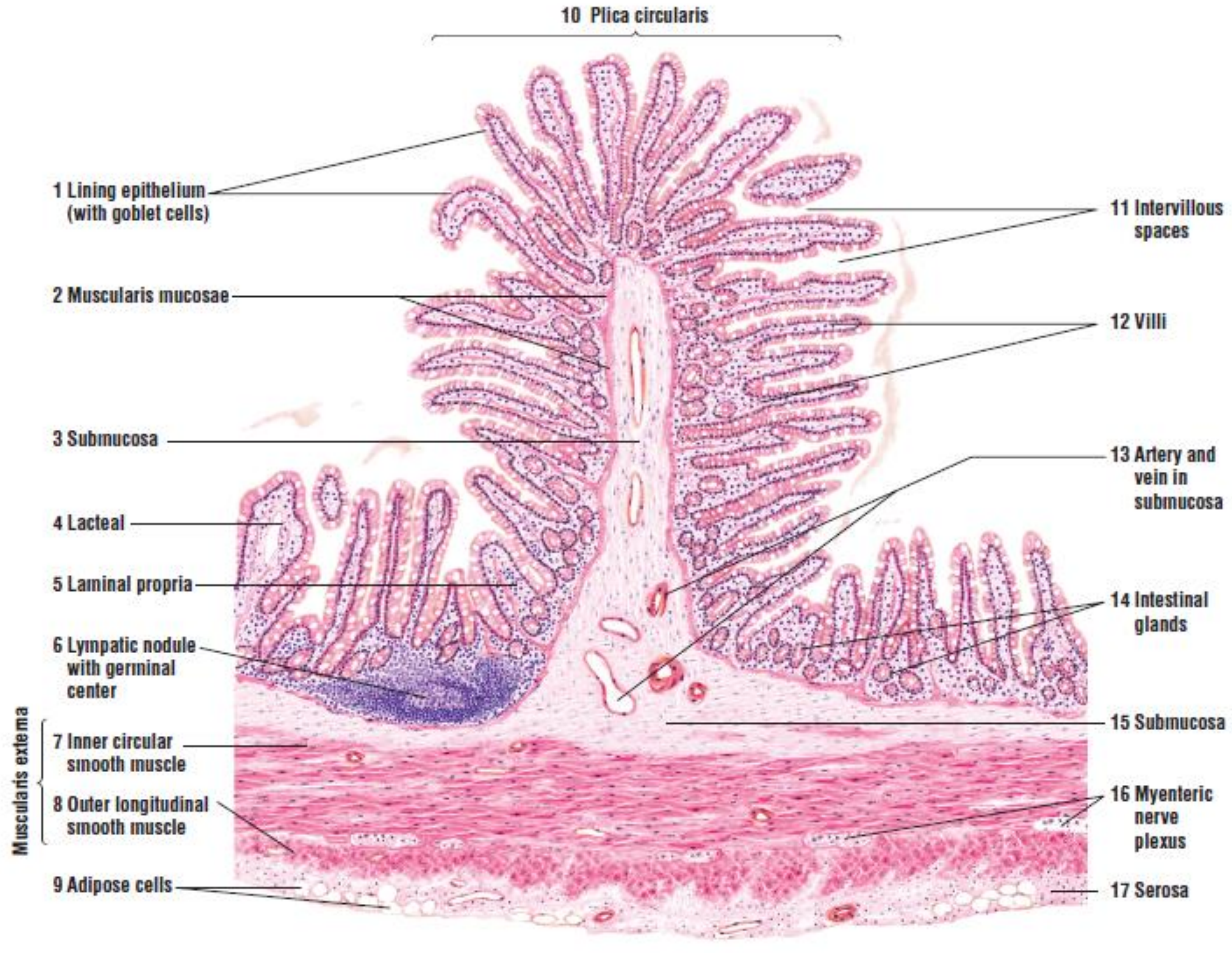


FIGURE 15.3 ■ Small intestine: jejunum (transverse section). Stain: hematoxylin and eosin. Low magnification.

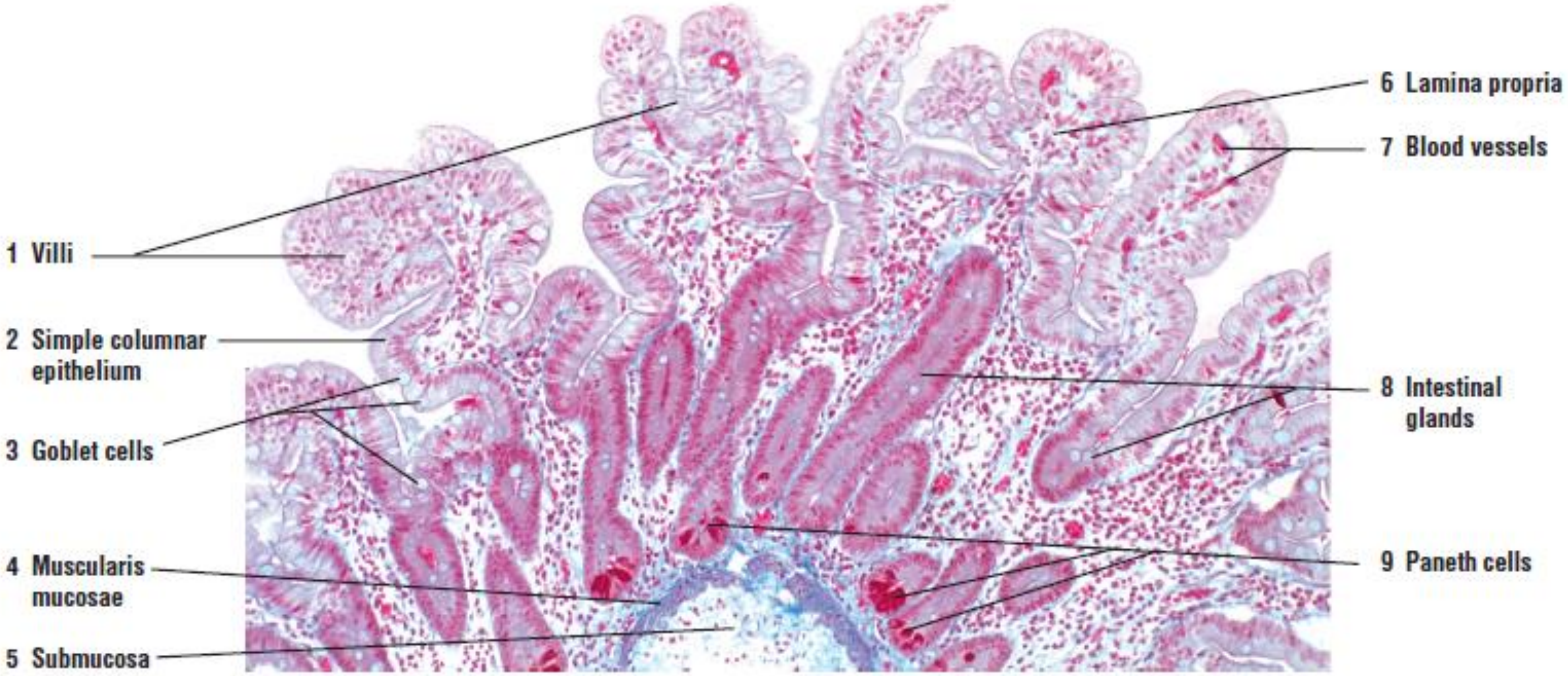


FIGURE 15.5 ■ Small intestine: jejunum with Paneth cells. Stain: Mallory-Azan. ×40.

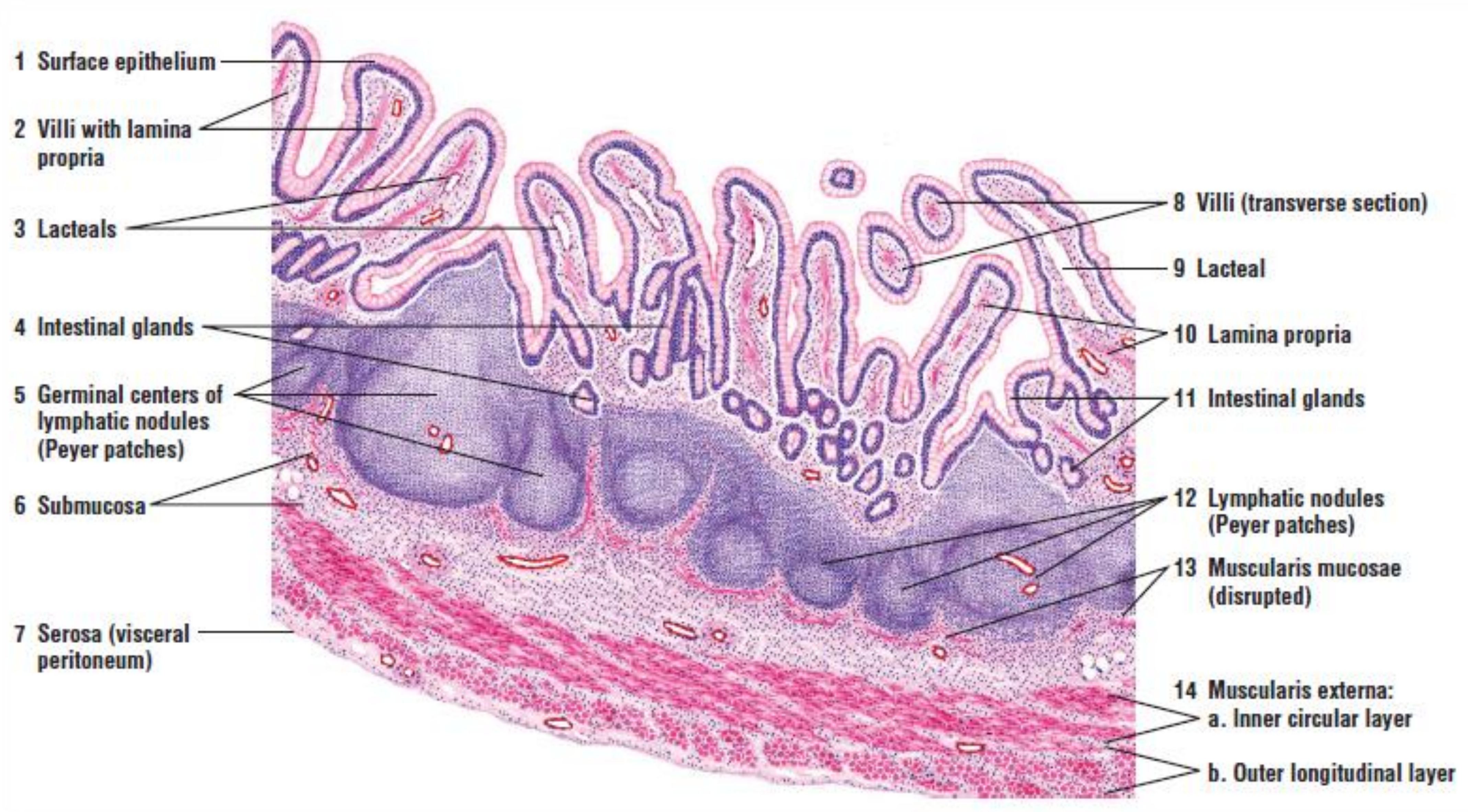


FIGURE 15.6 ■ Small intestine: ileum with lymphatic nodules (Peyer patches) (transverse section). Stain: hematoxylin and eosin. Low magnification.

DON'T GIVE UP

THE LARGE INTESTINE

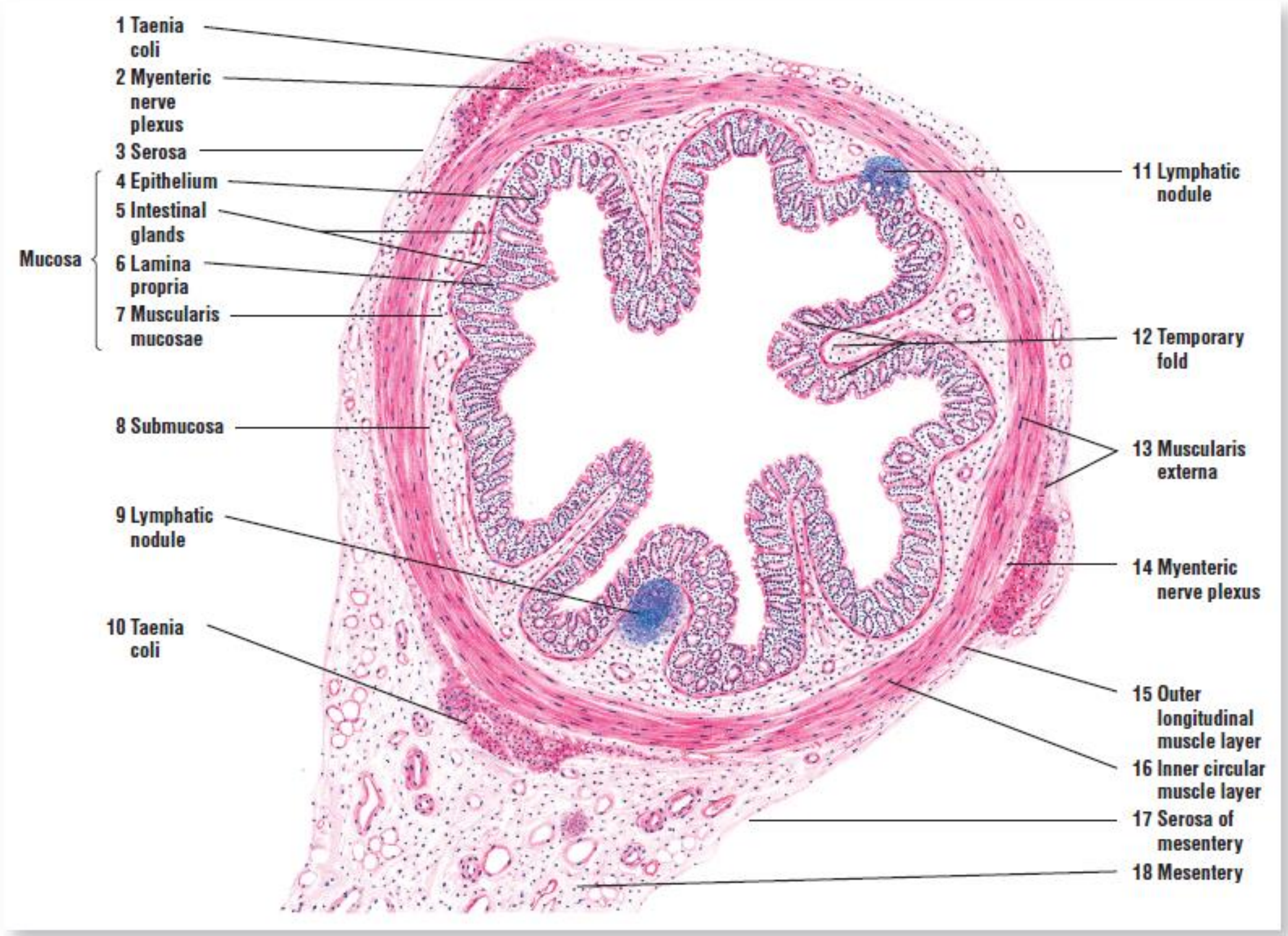
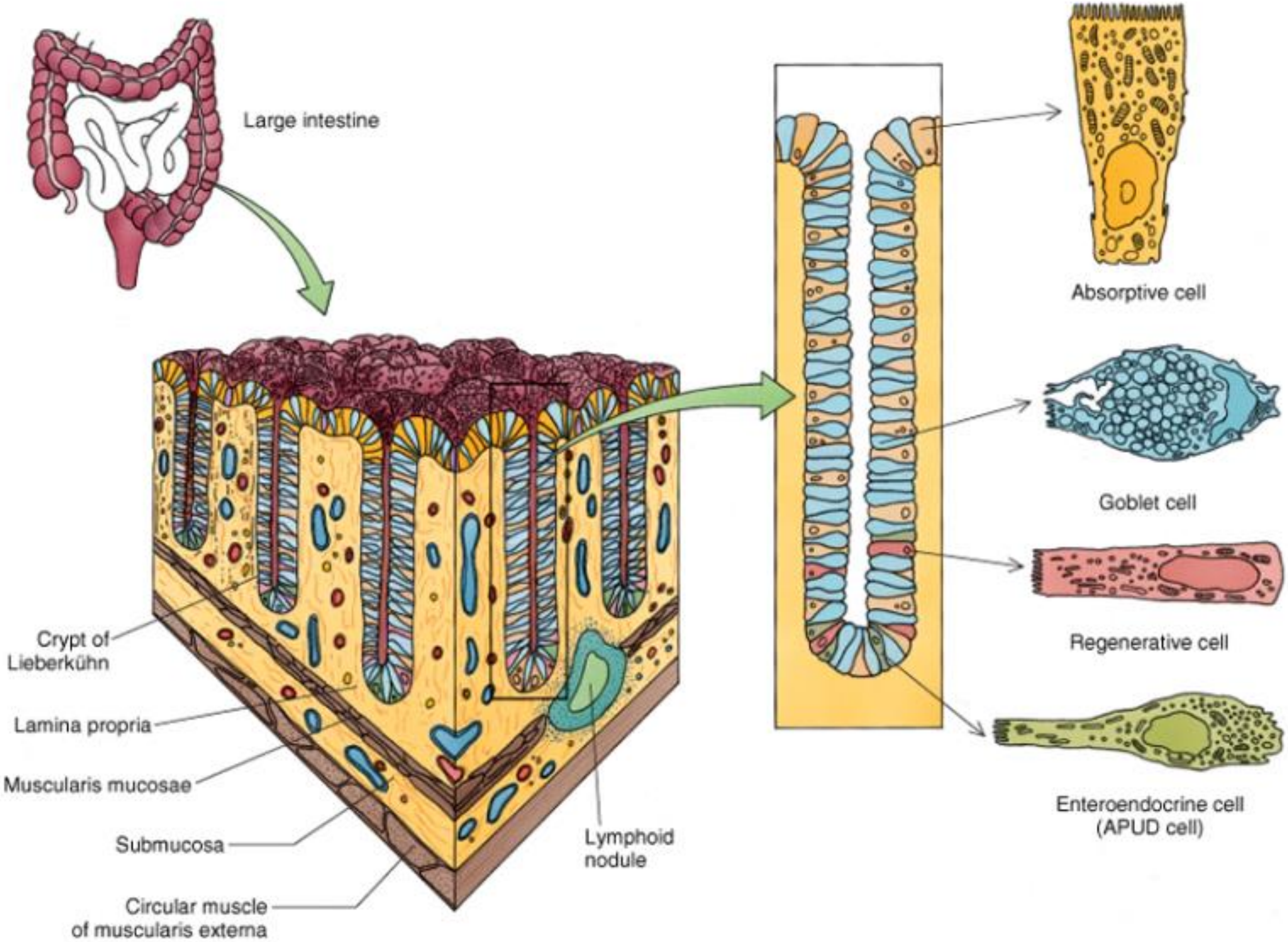
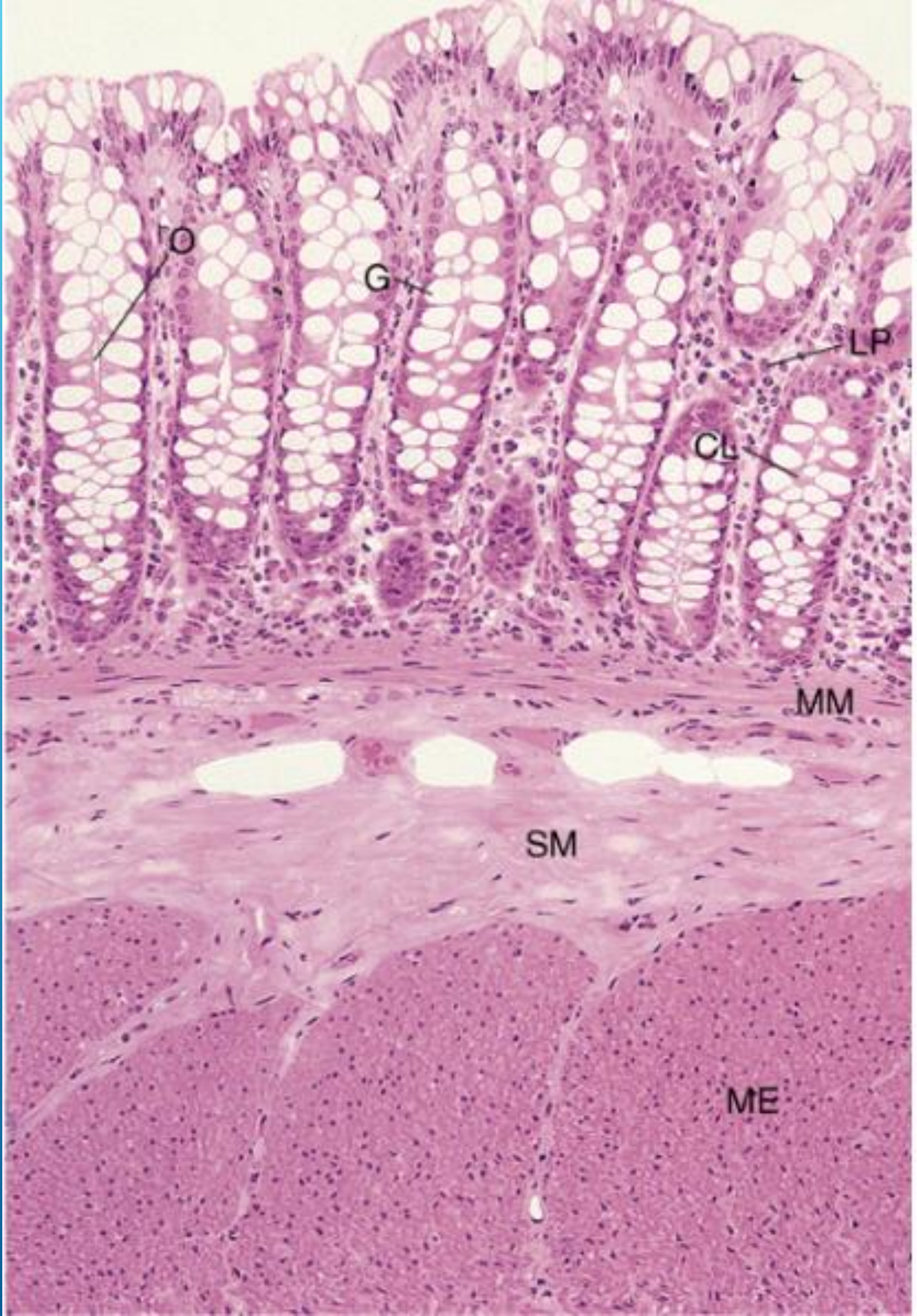


FIGURE 15.9 ■ Large intestine: colon and mesentery (panoramic view, transverse section). Stain: hematoxylin and eosin. Low magnification.

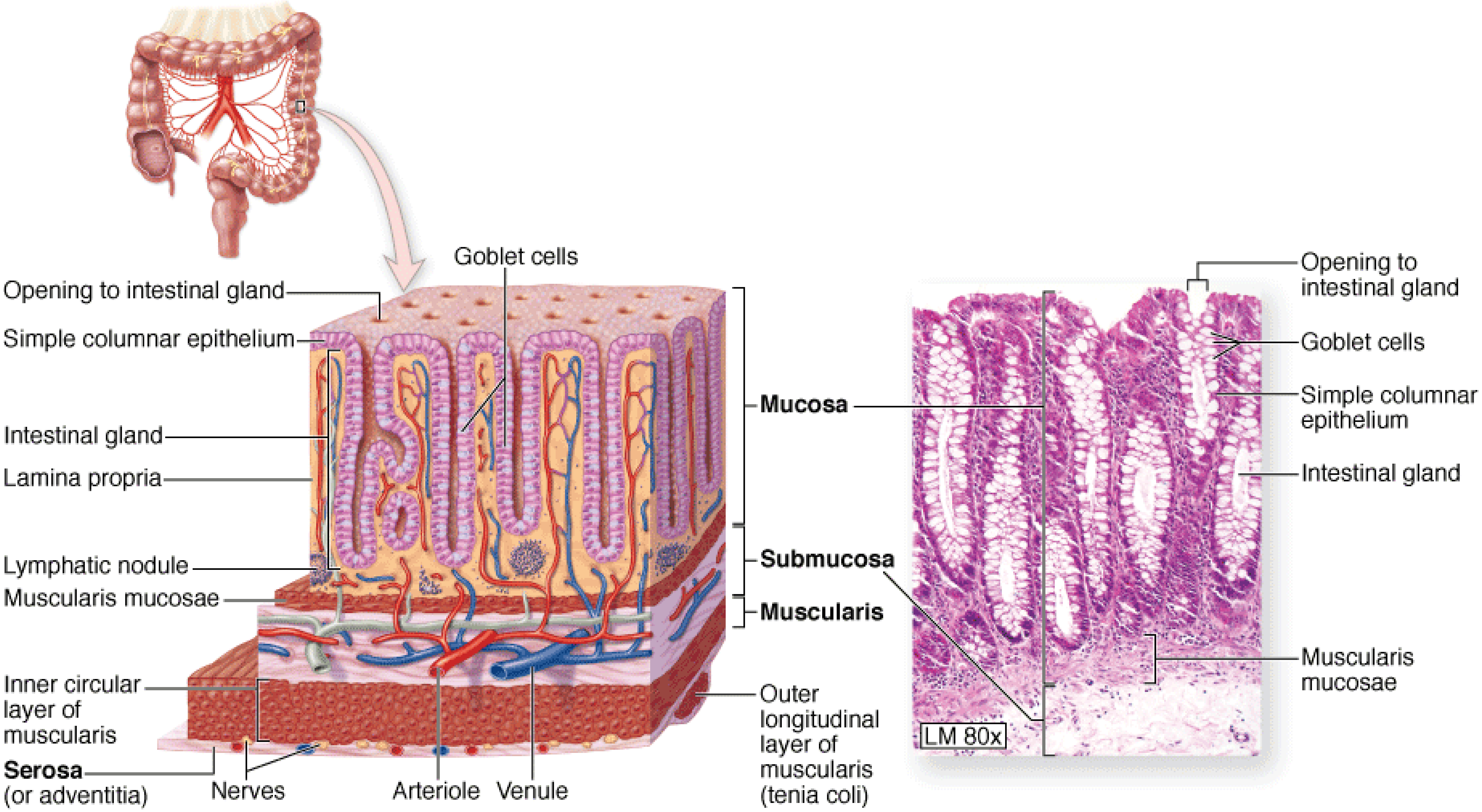


Large intestine
Absorptive cell
Goblet cell
Regenerative cell
Enteroendocrine cell
(APUD cell)
Crypt of
Lieberkühn
Lamina propria
Muscularis mucosae
Submucosa
Circular muscle
of muscularis externa
Lymphoid
nodule



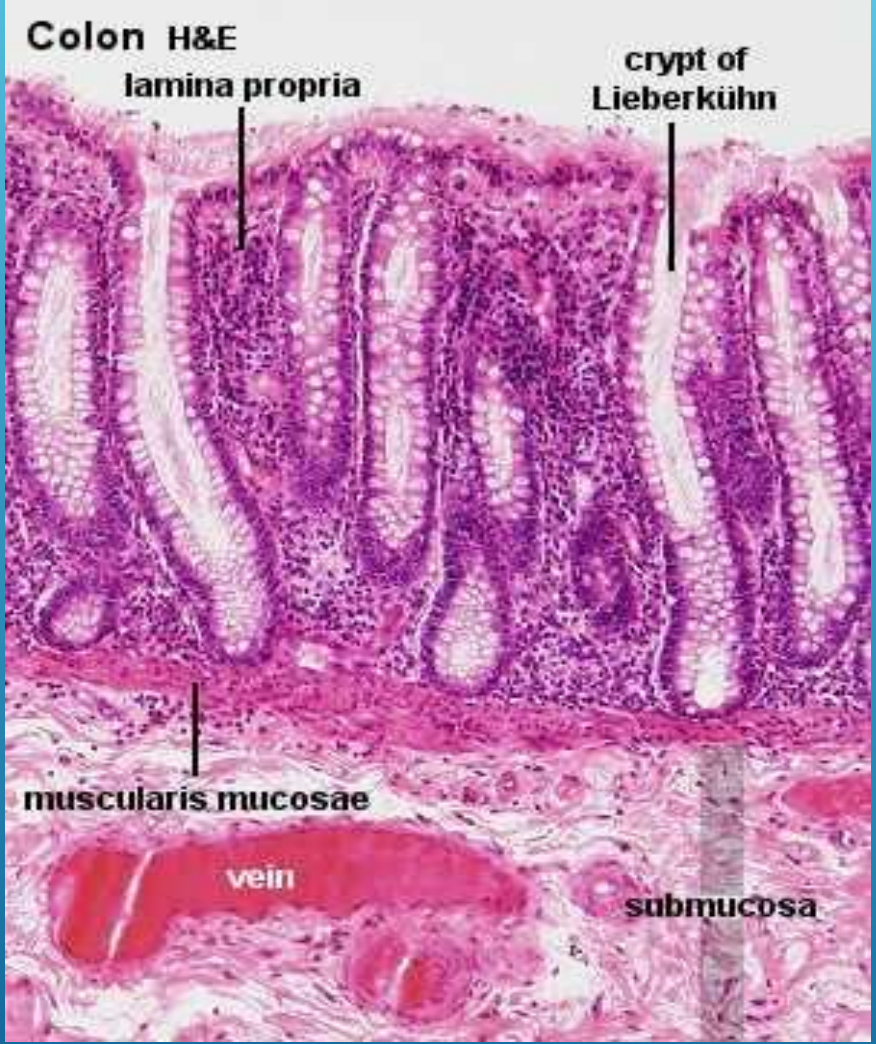
LARGE INTESTINE

G = Goblet cells
CL = Crypts of lieberkuhn
LP = Lamina propria
SM = Submucosa
MM = Mscularis mucosa
O = Open lumen of crypts of lieberkuhn

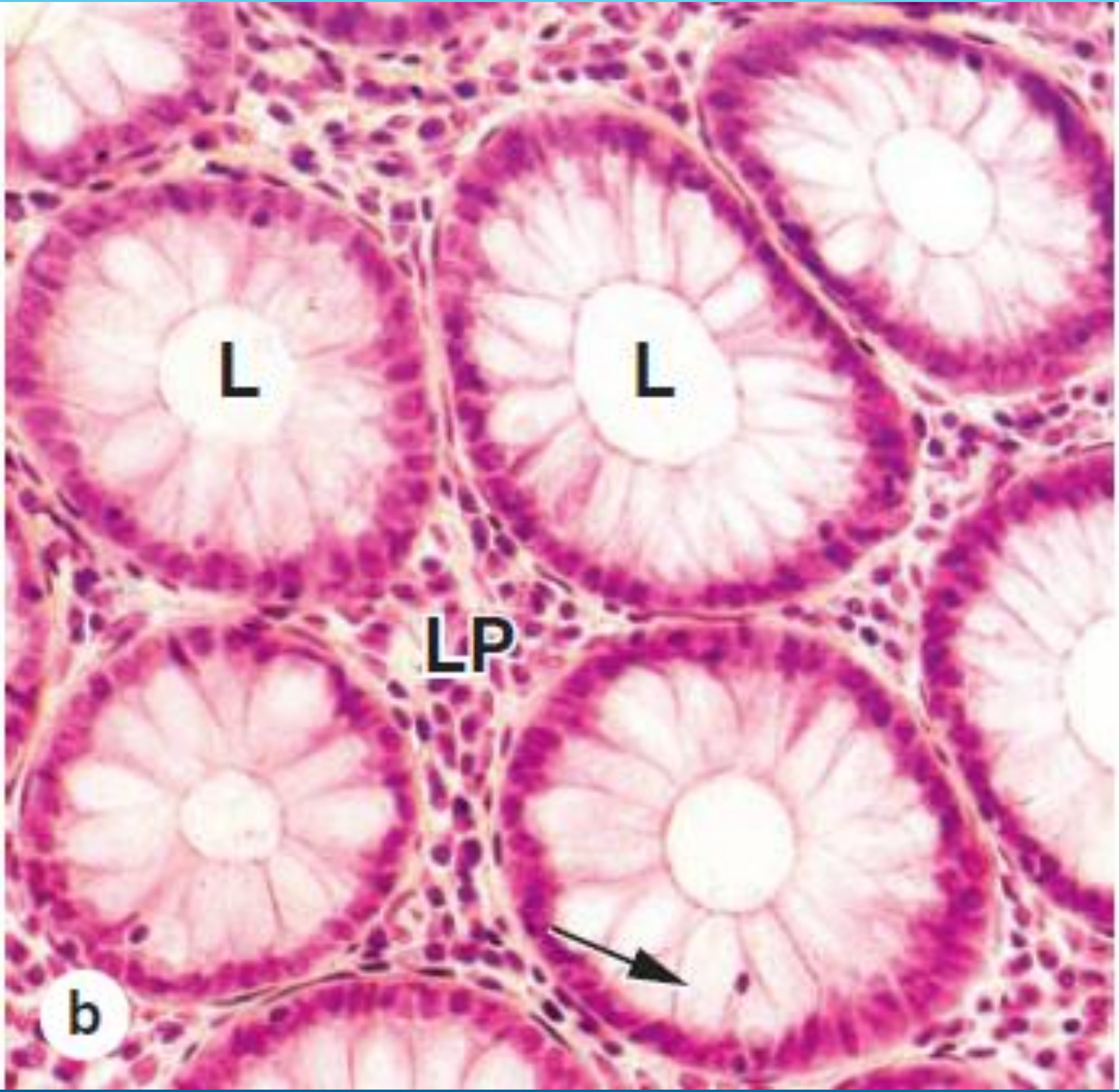


a Large intestine tunics

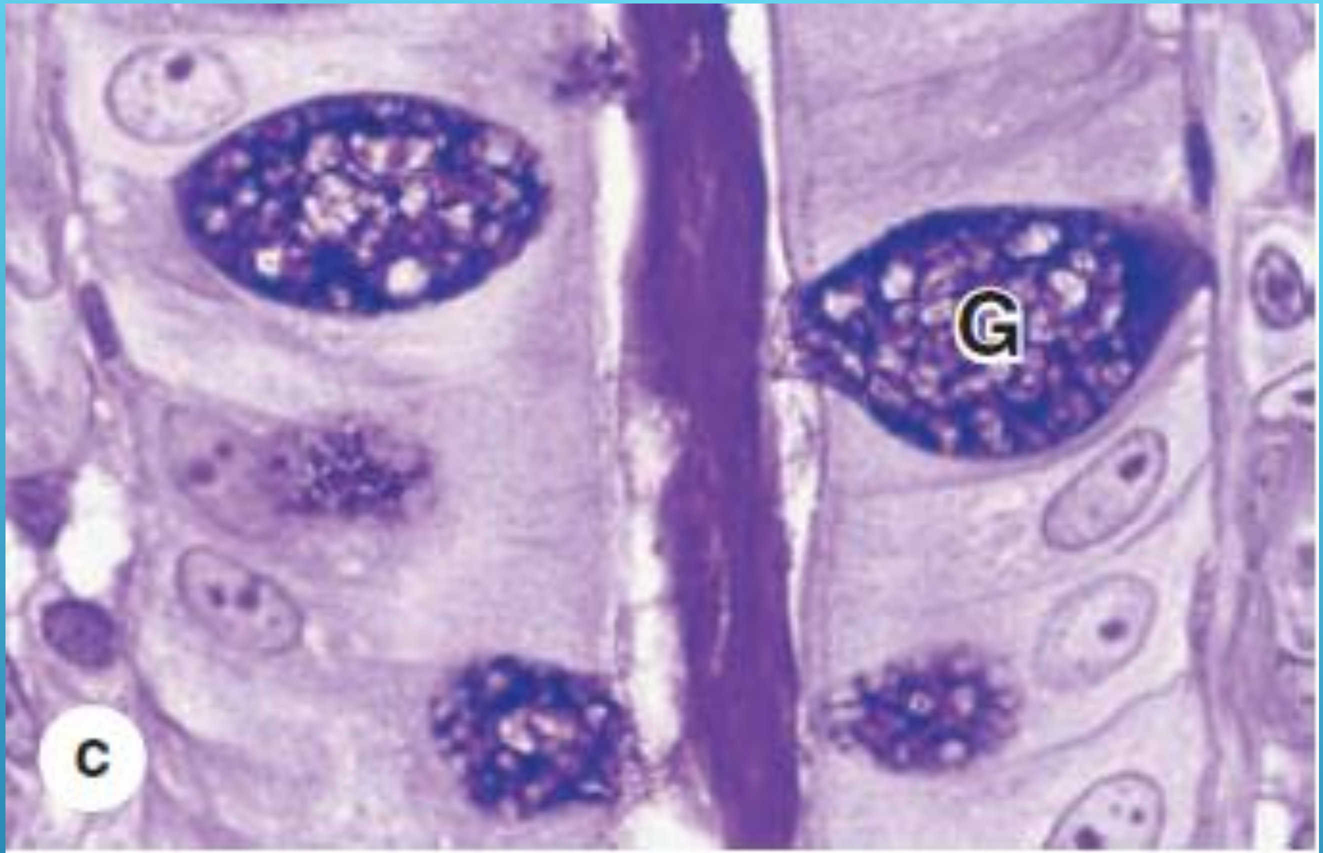
b Large intestine mucosa and submucosa



Transverse section of the colon shows the muscularis externa (ME), including a tenia coli cut transversely in the lower part of the figure, the submucosa (S), the mucosa (M)
filled with tubular intestinal glands. Some of these glands are cut longitudinally, but most seen here are cut transversely.

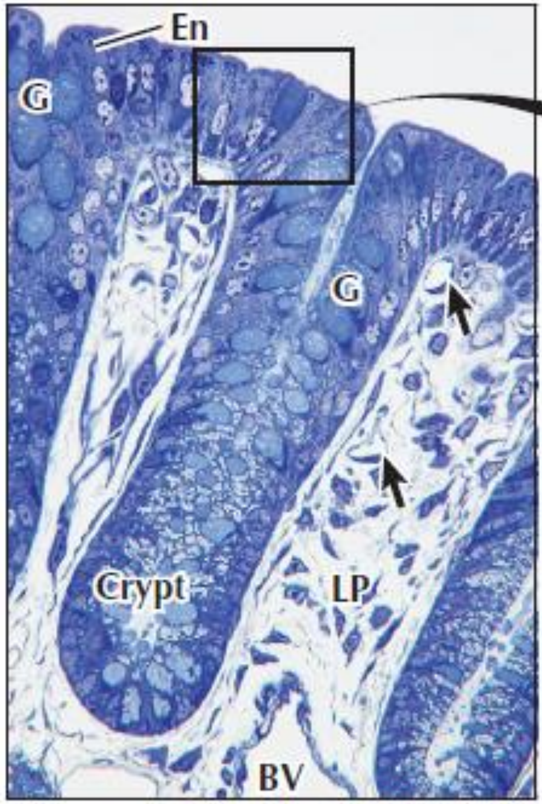


Transversely cut glands are seen to consist of simple columnar epithelium surrounded by a tubular lumen (L) and embedded in lamina propria (LP) with many free lymphocytes. Lymphocytes can also be seen penetrating the epithelium (arrow)

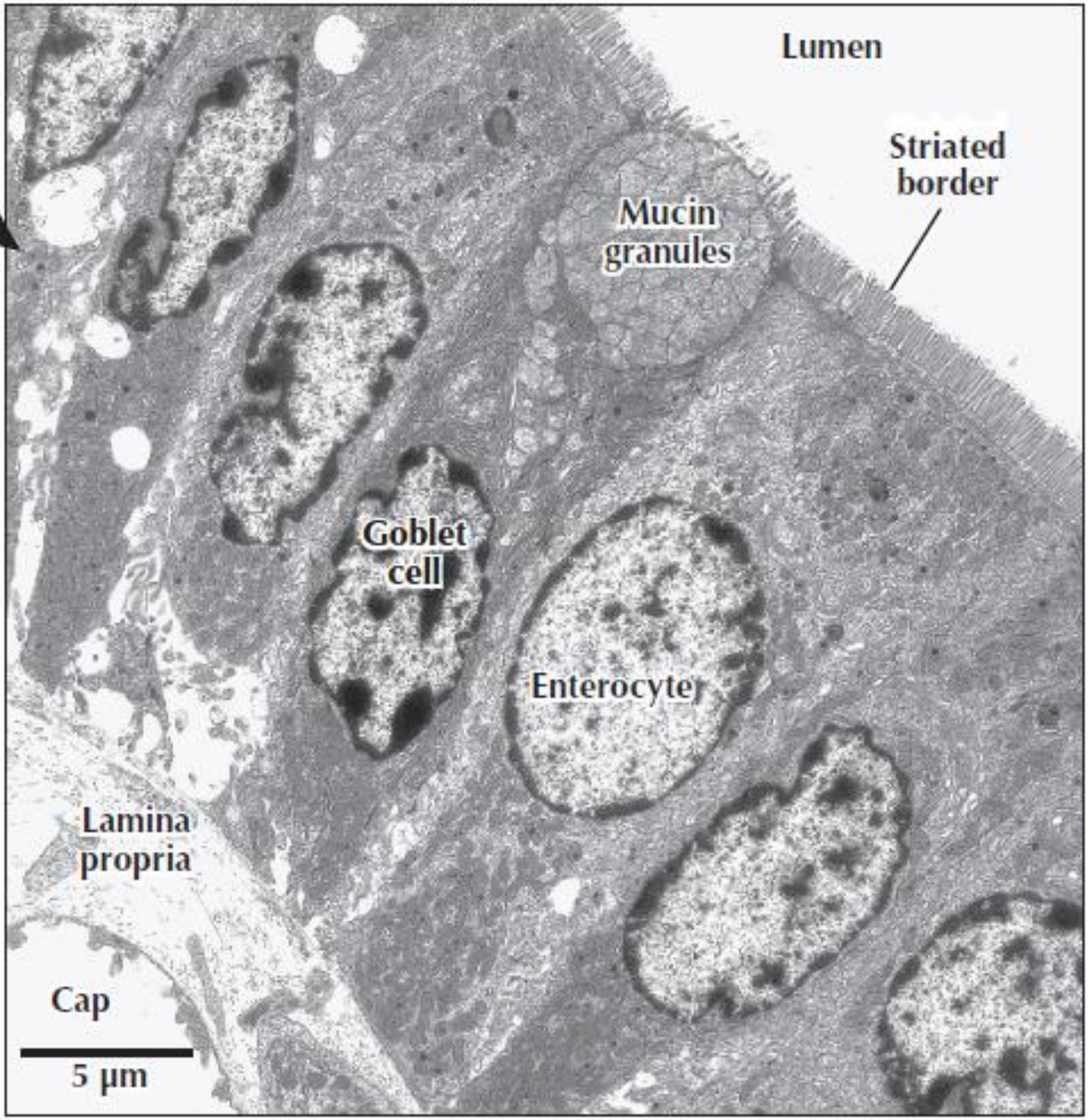


Longitudinal section of one intestinal gland stained for glycoproteins shows mucus in the lumen and two major cell types in the epithelium: goblet cells (G) and the neighboring columnar cells specialized for water absorption.

FIGURE 15.10 ■ Large intestine: colon wall (transverse section). Stain: hematoxylin and eosin. ×30.



▲ **LM of the colonic mucosa.** Surface epithelium containing goblet cells (**G**) and enterocytes (**En**) invaginates to form an intestinal crypt. The lamina propria (**LP**), with capillaries (**arrows**) and larger blood vessels (**BV**), is richly cellular. 600×. *Toluidine blue.*



EM of the colonic mucosa. Enterocytes have an apical striated border of microvilli that project into the lumen.

These cells occur with goblet cells, which have apical mucin granules. The lamina propria contains a capillary (**Cap**).

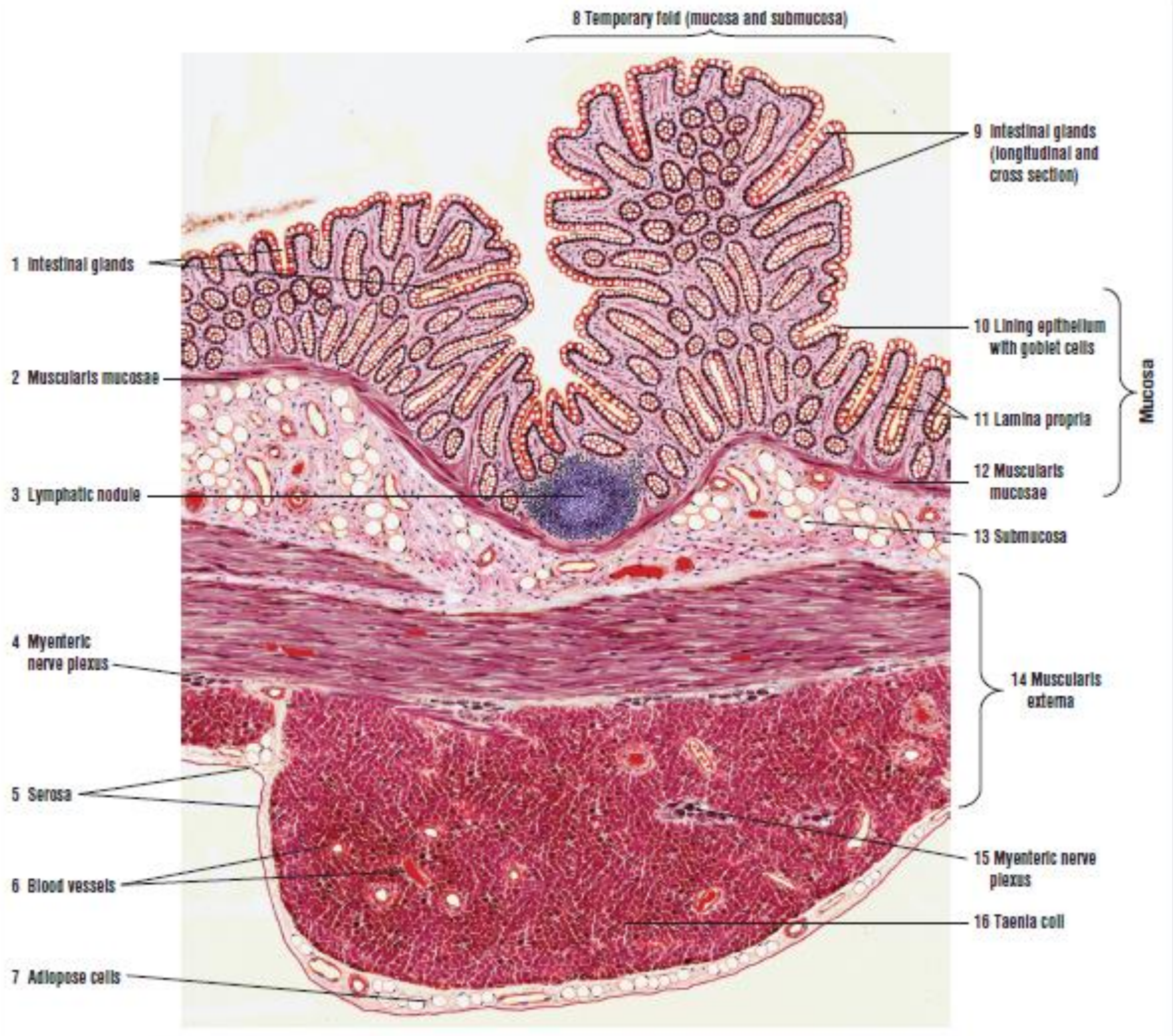
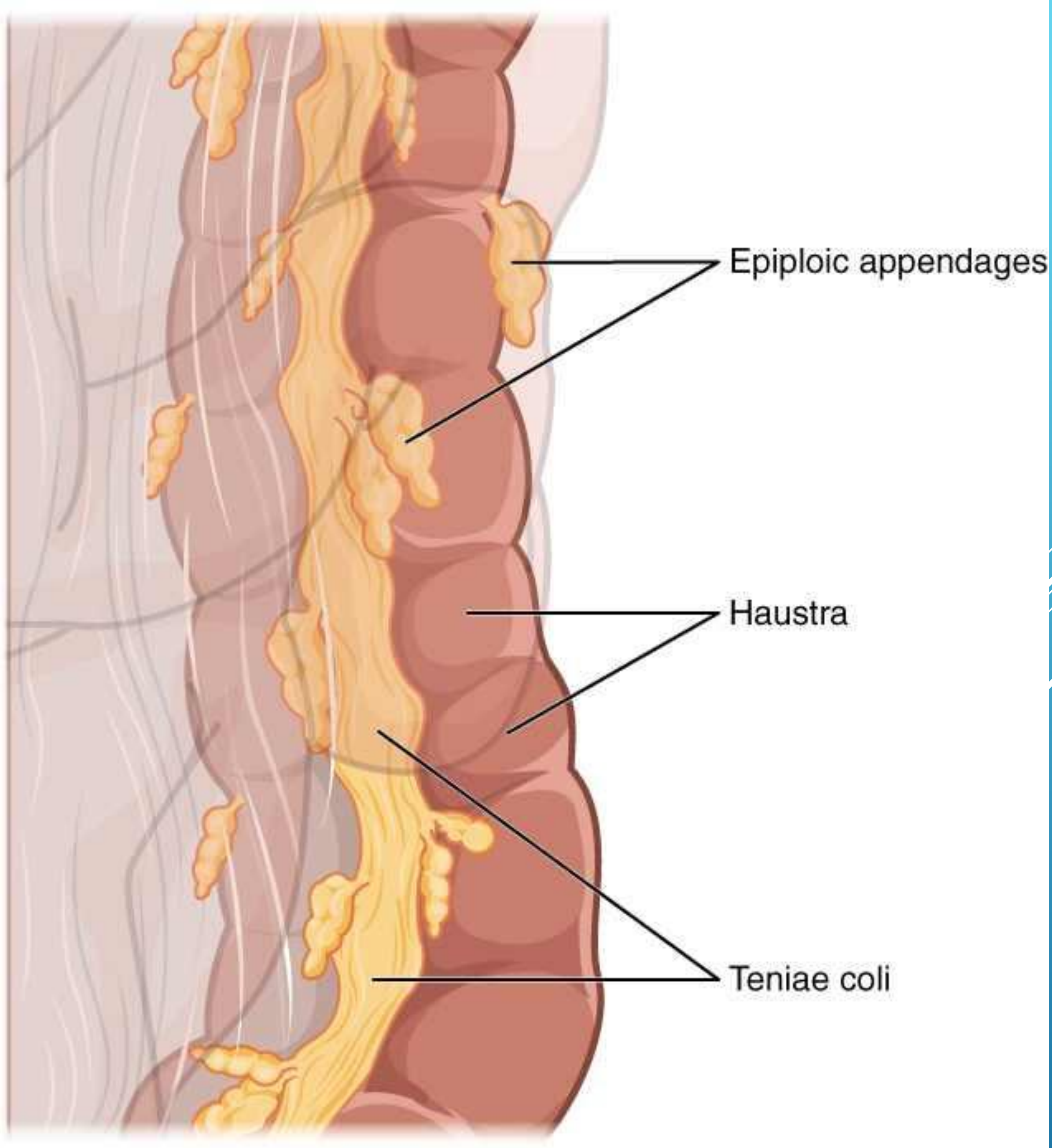
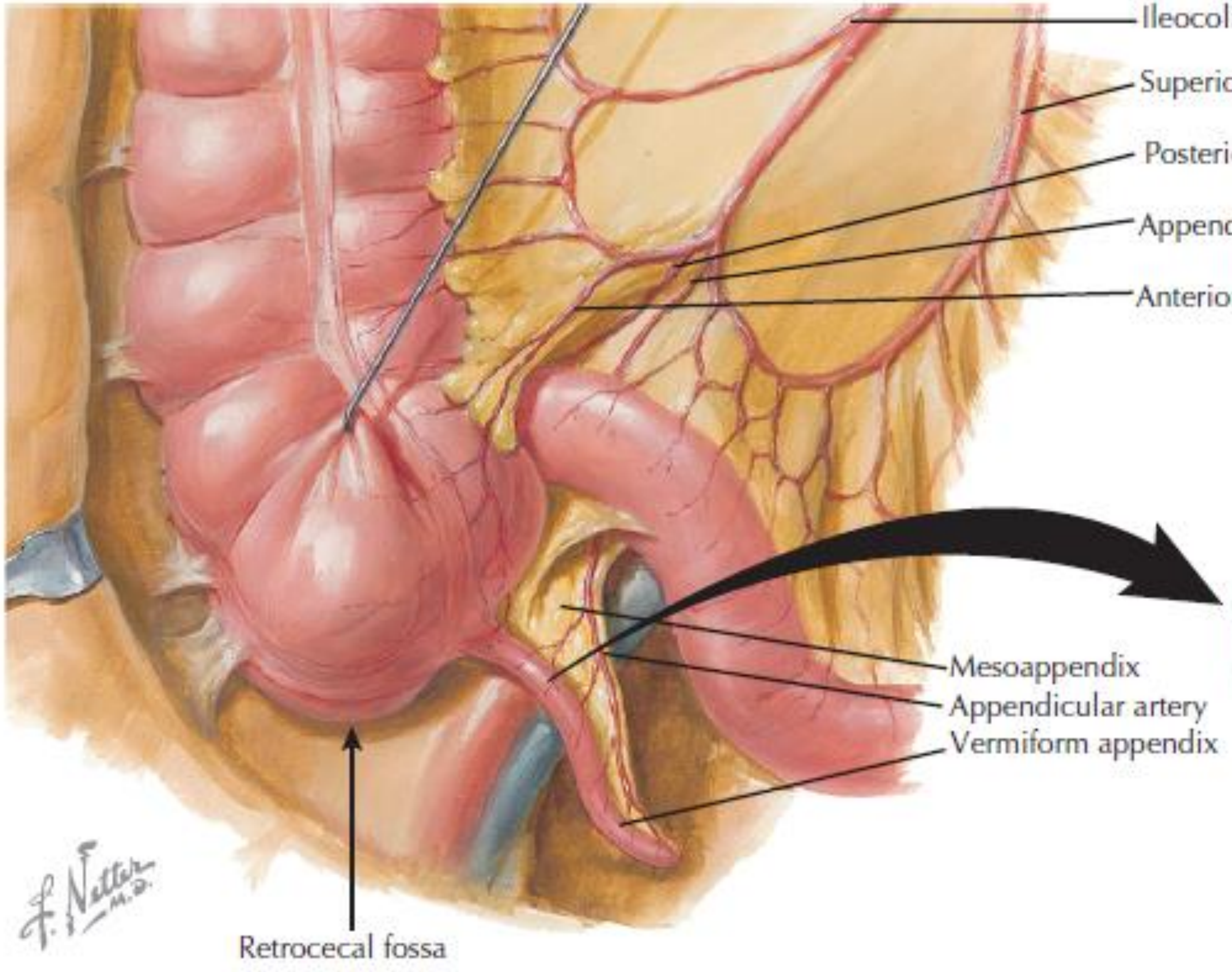


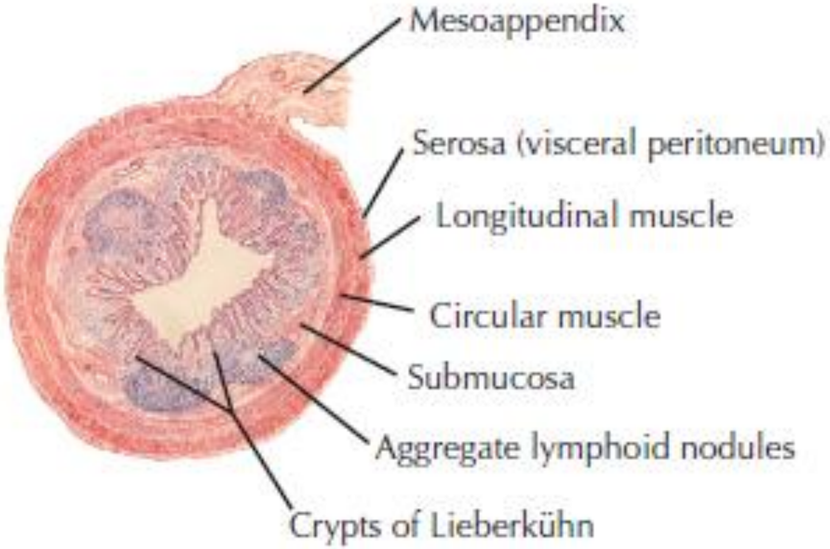
FIGURE 15.11 ■ Large intestine: colon wall (transverse section). Stain: hematoxylin and eosin. Medium magnification.

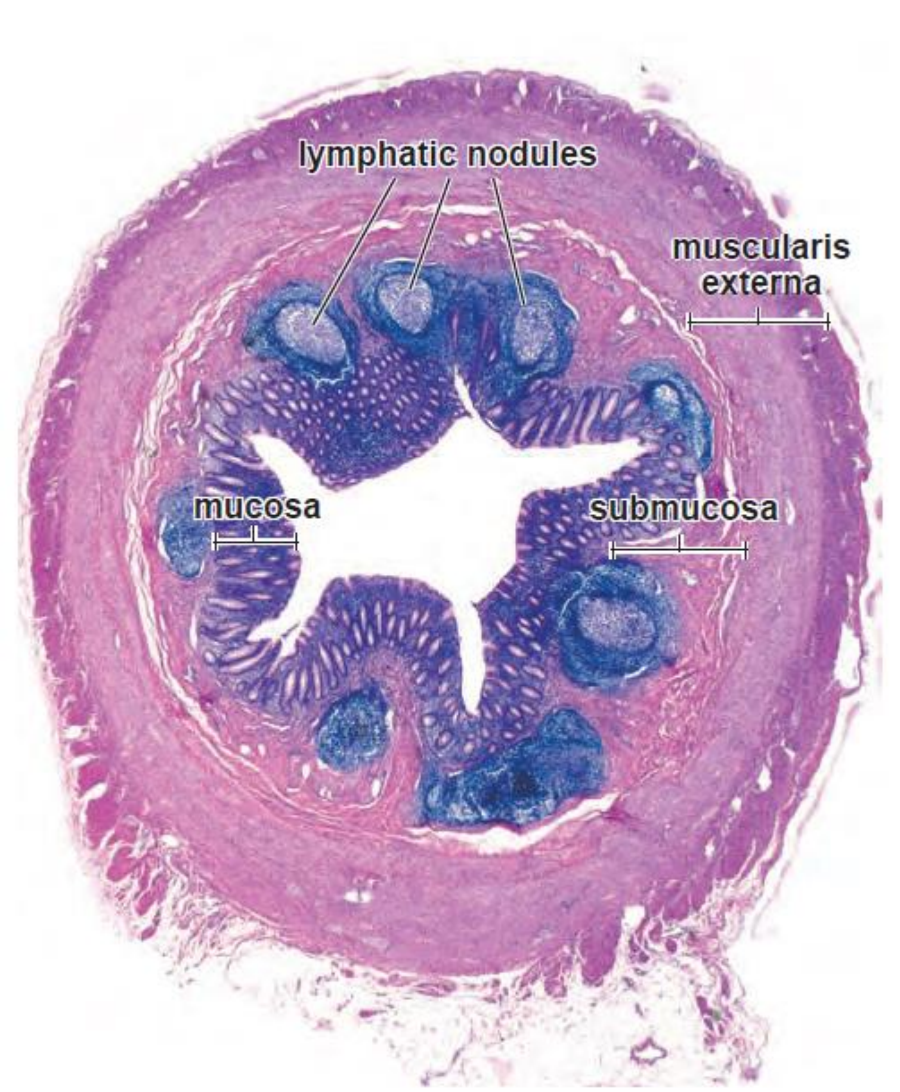


▼ Ileocecal region.



▼ Cross section of appendix.





THE VERMIFORM APPENDIX

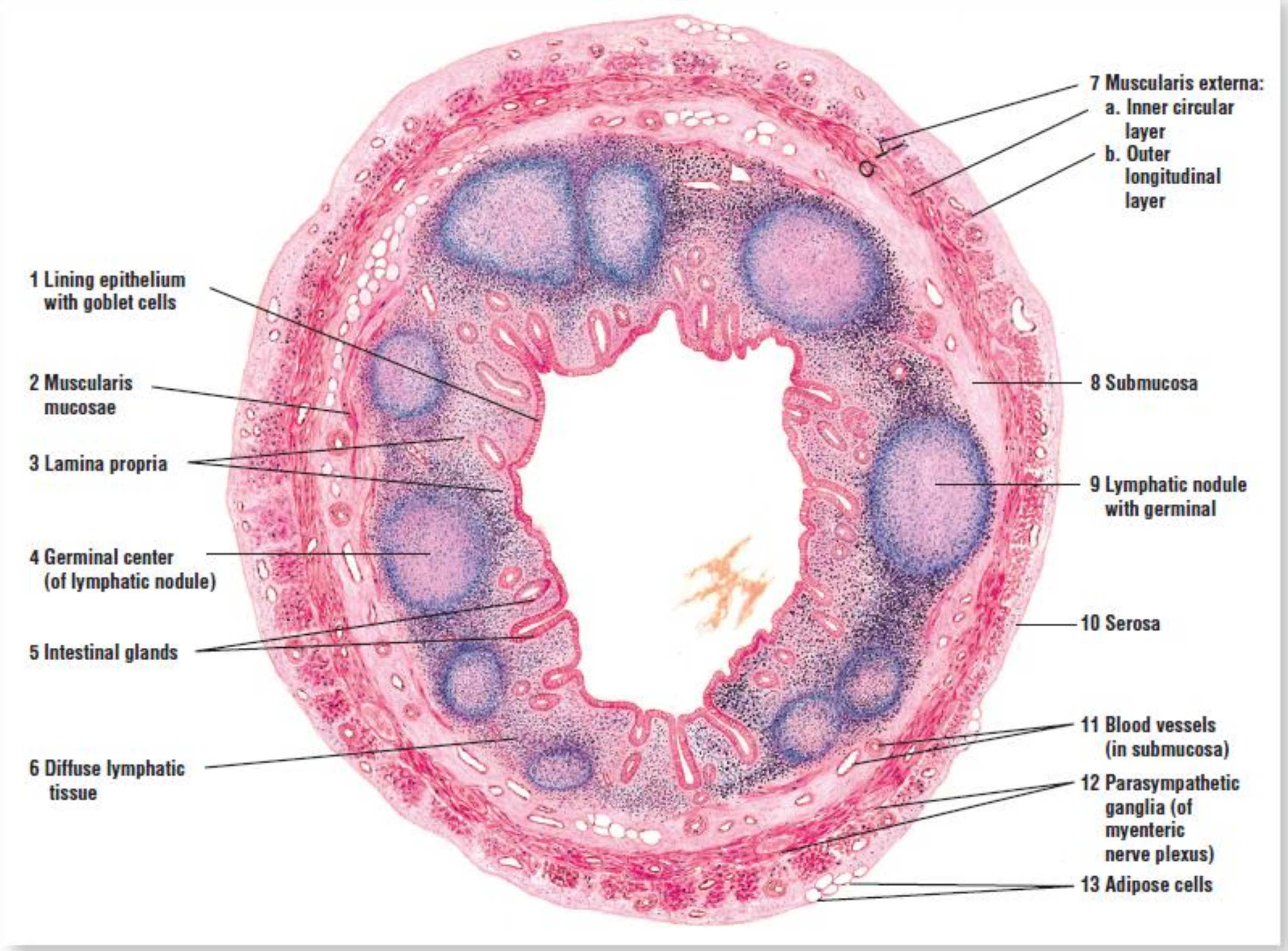
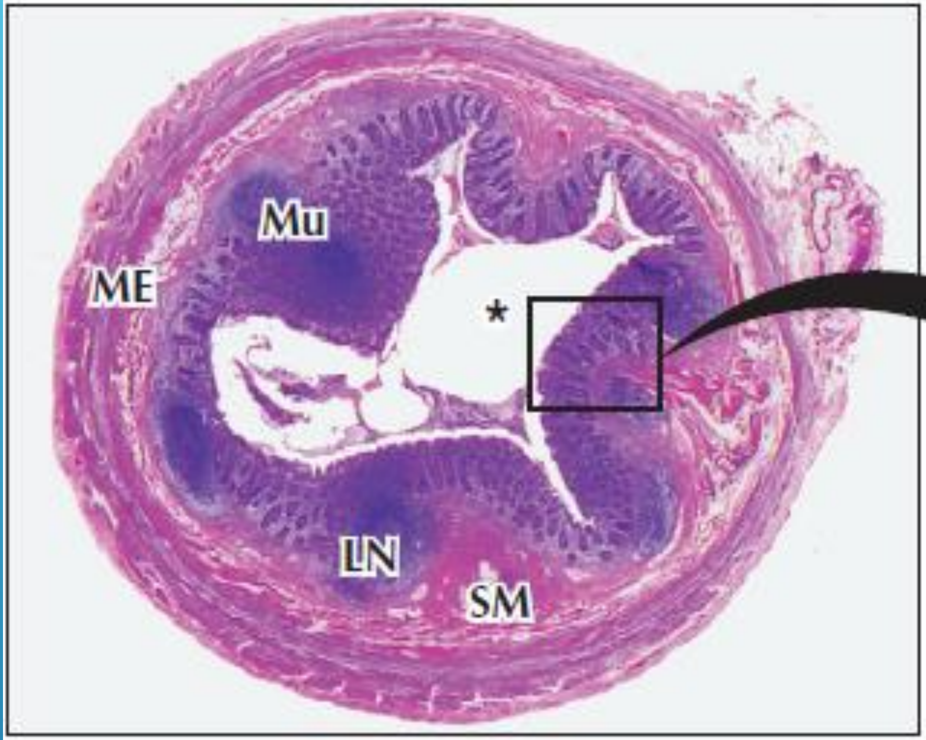
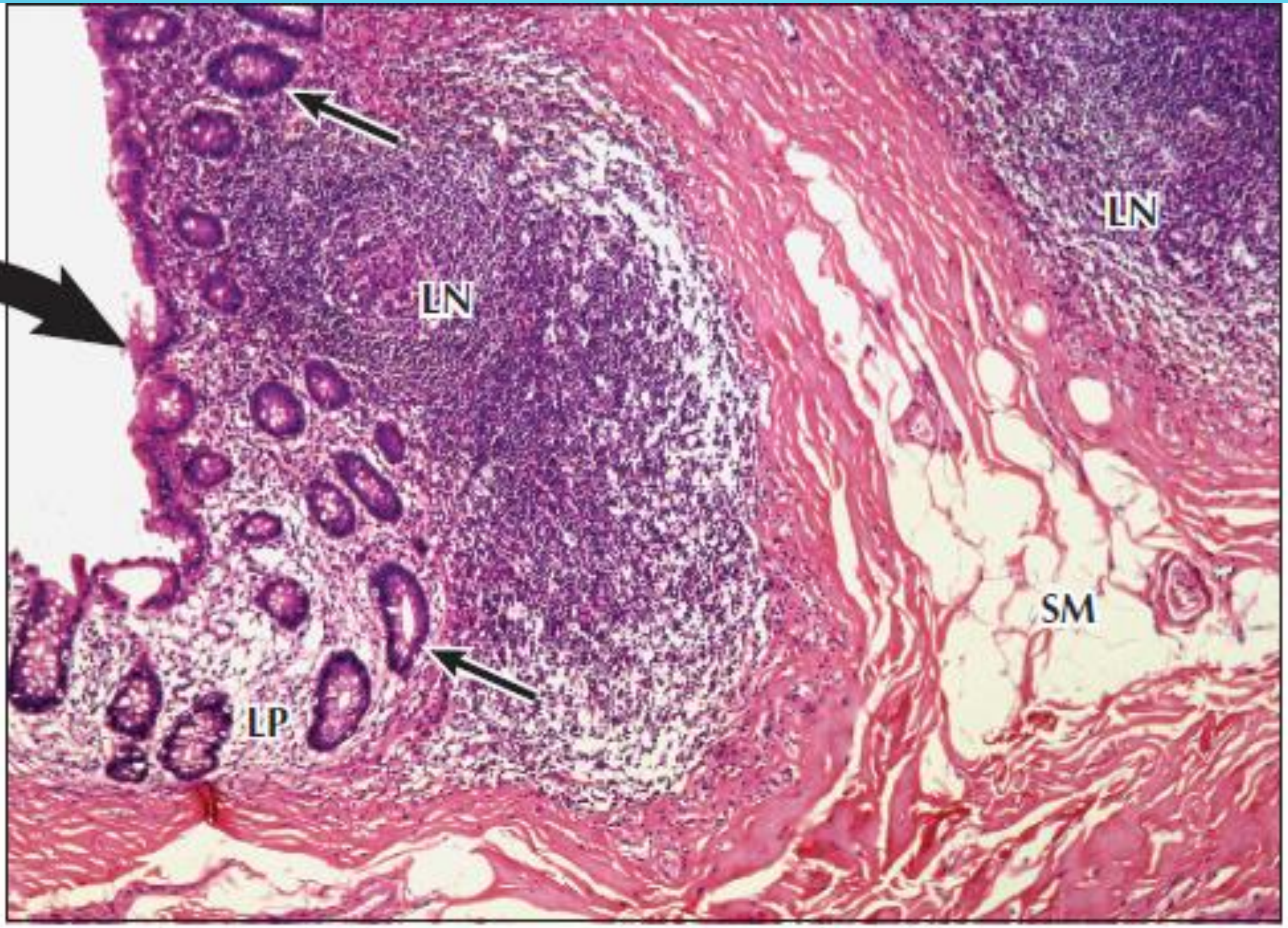


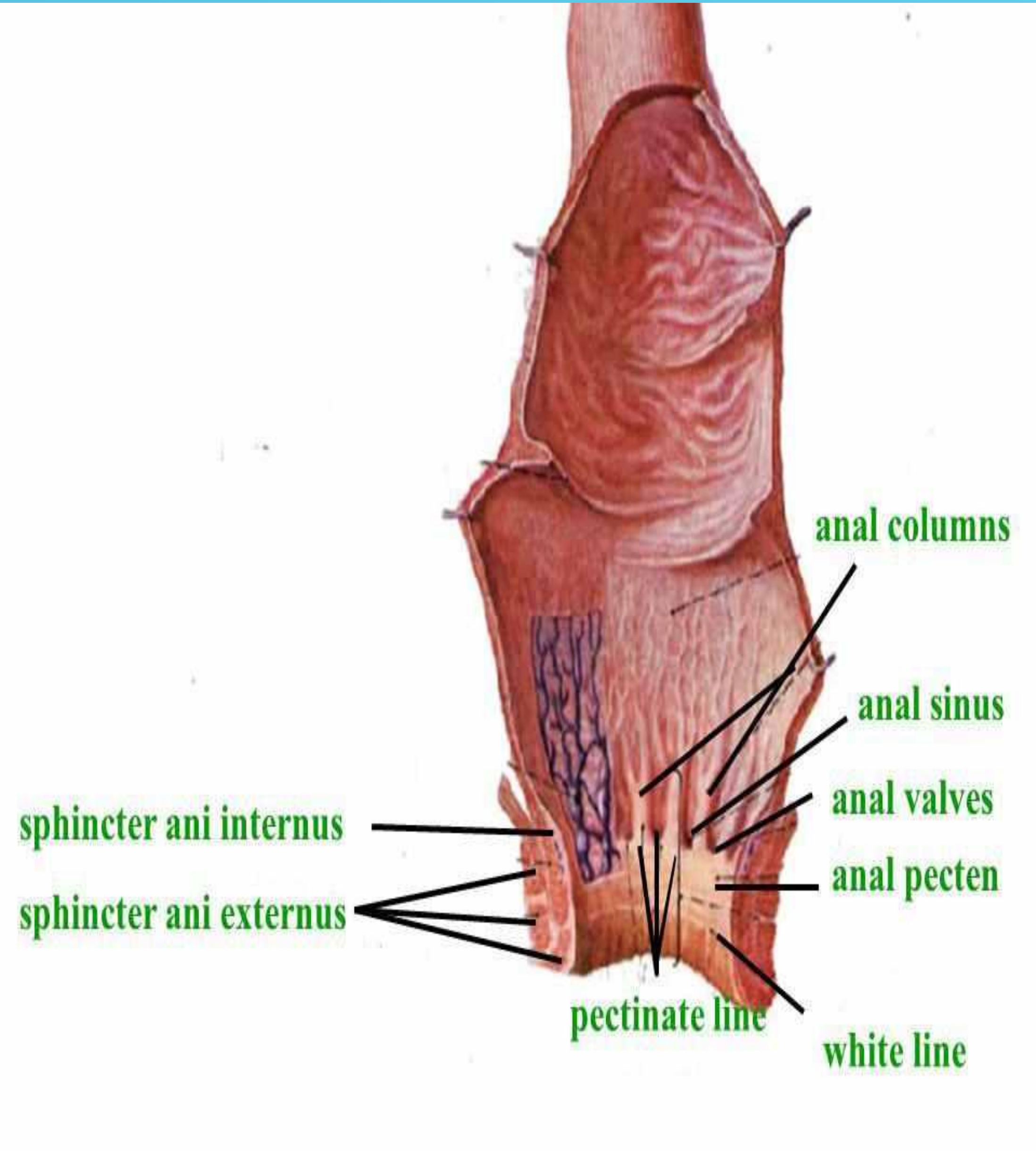
FIGURE 15.12 ■ Appendix (panoramic view, transverse section). Stain: hematoxylin and eosin. Low magnification.

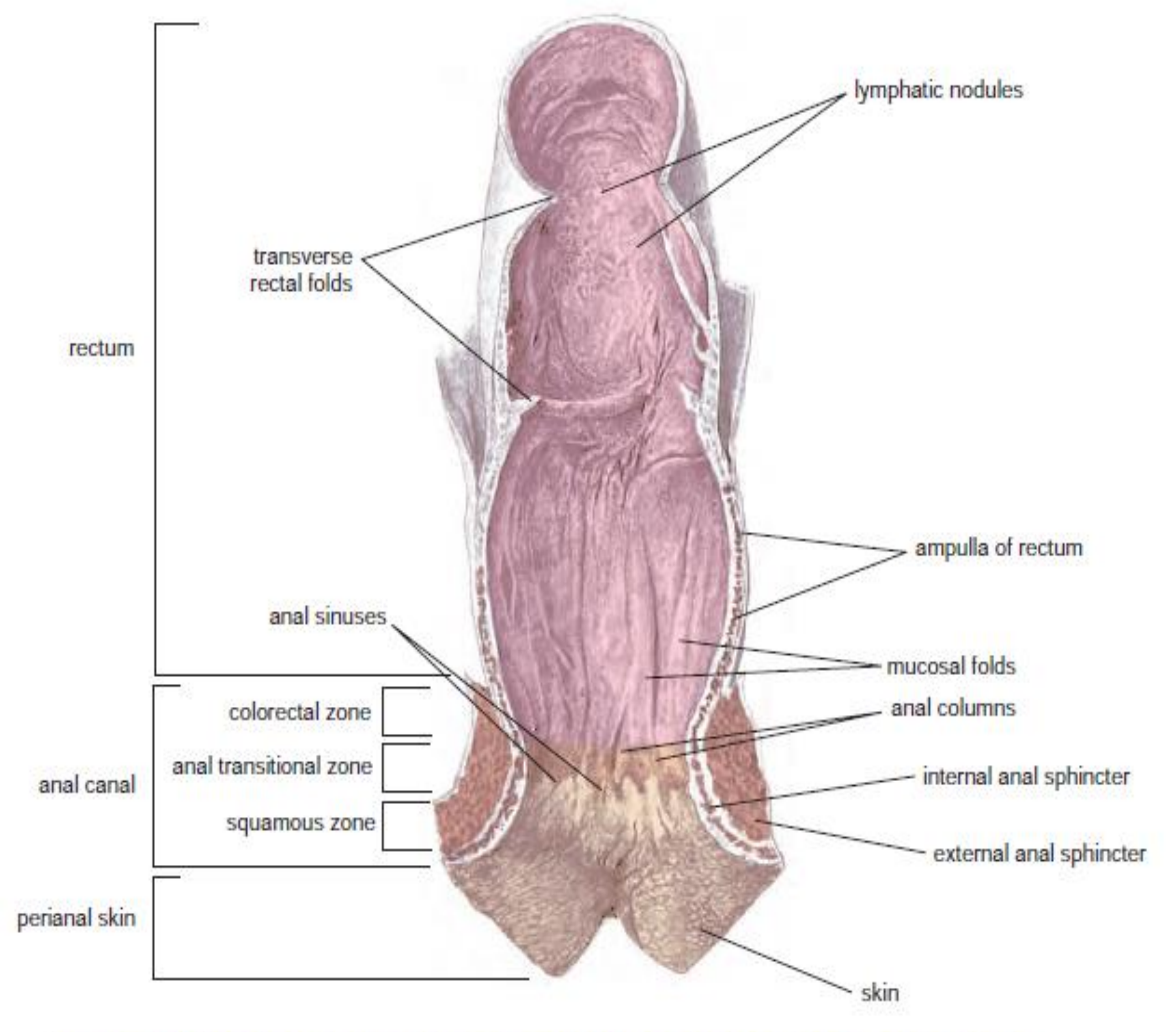


▲ **LM of the appendix in transverse section.** Prominent mucosa (**Mu**) shows multiple lymphoid nodules (**LN**) bulging into a narrow stellate lumen (*). Connective tissue makes up a submucosa (**SM**); the muscularis externa (**ME**) contains two layers of smooth muscle. 8×. *H&E.*



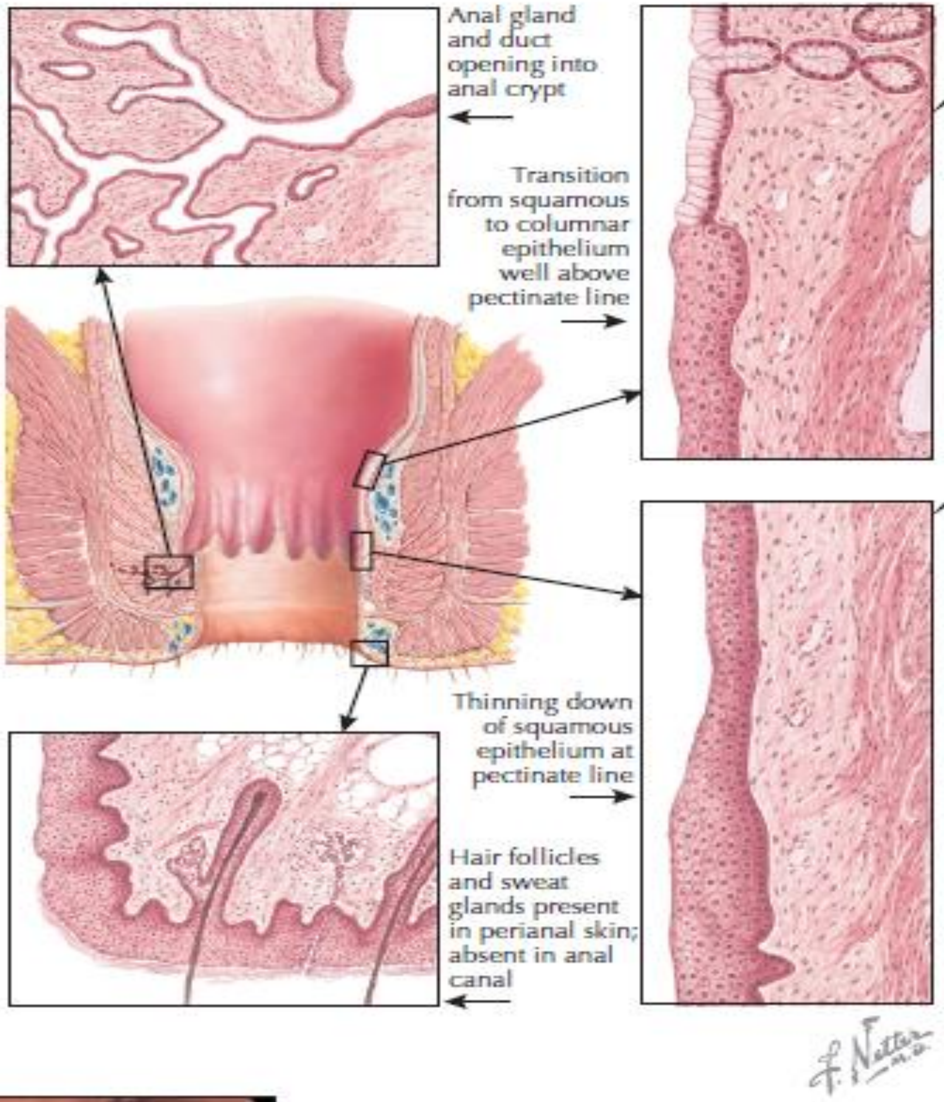
▲ **LM of part of the appendix.** Mucosa contains richly cellular lamina propria (**LP**) infiltrated with lymphoid nodules (**LN**) that extend into submucosa (**SM**). Shallow invaginations of the surface—intestinal crypts (**arrows**)—vary in length. The submucosa has some adipose tissue. 85×. *H&E.*

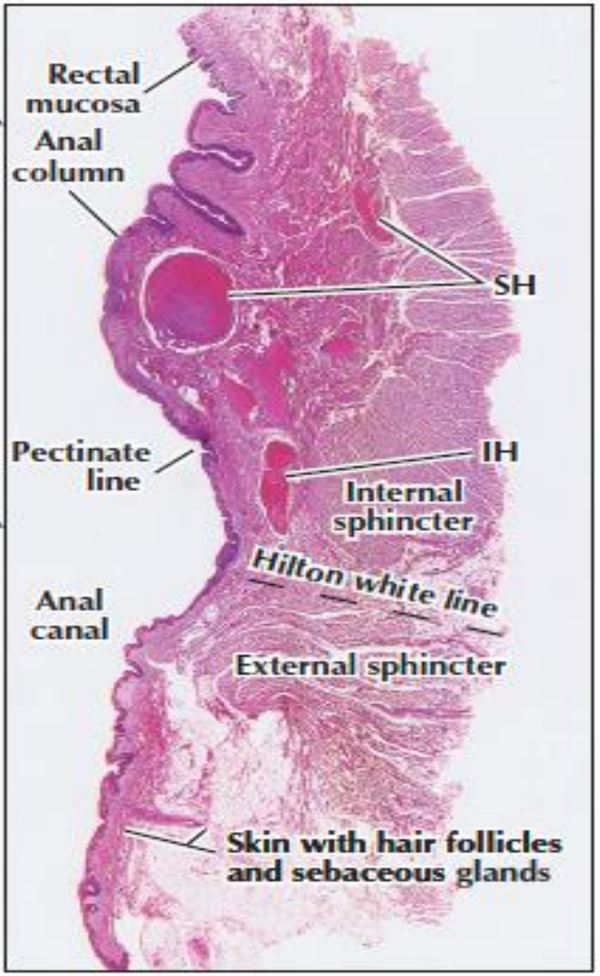




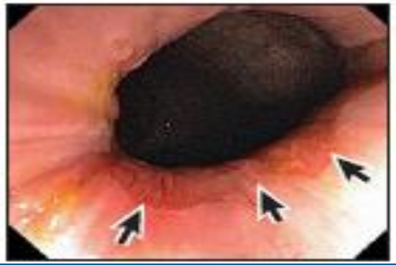
DRAWING OF THE RECTUM AND ANAL CANAL

▼ **Rectum and anal canal.**



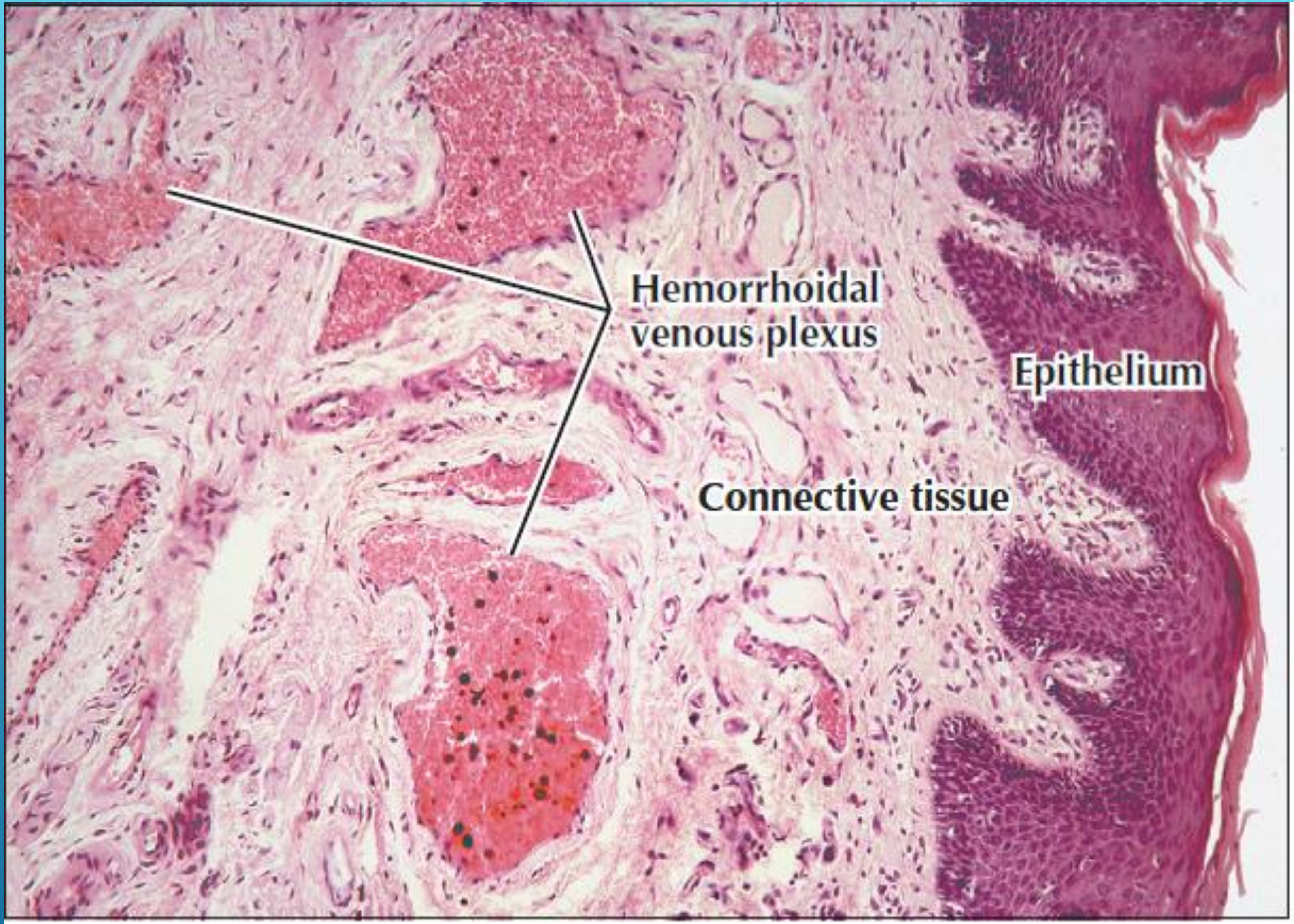


▲ **LM of the anorectal junction in longitudinal section.** The rectum (at top) leads into the anal canal (at bottom). The squamocolumnar junction occurs well above the pectinate line. Other features are indicated. Superior (**SH**) and inferior (**IH**) hemorrhoidal venous plexuses—thin-walled veins filled with blood—lie on both sides of the pectinate line. 5×. *H&E.*



◄ **Endoscopic view of the anorectal junction.** The transition from rectum to anal canal is near the serrated pectinate line (**arrows**), which shows a color change on the surface. It marks the squamocolumnar junction.

LM OF THE MUCOSA OF THE ANAL CANAL



Further along the canal, epithelium becomes stratified squamous. Just below the pectinate line, it is nonkeratinized, but it becomes keratinized. In connective tissue under the epithelium is a plexus of thin-walled hemorrhoidal veins.

THE SITE OF JUNCTION BETWEEN THE DIFFERENT PARTS OF THE DIGESTIVE TUBE

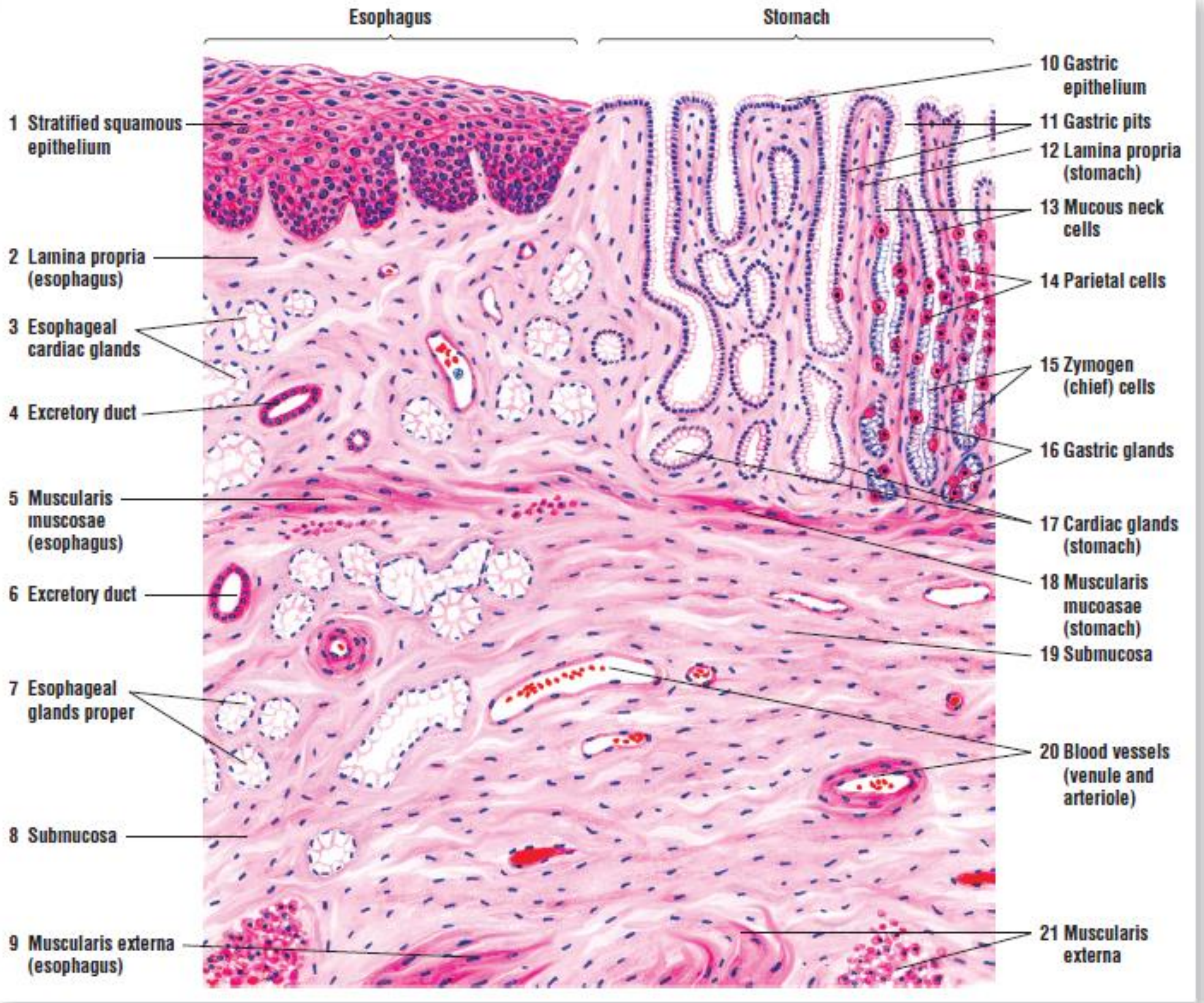


FIGURE 14.6 ■ Esophageal–stomach junction. Stain: hematoxylin and eosin. Low magnification.

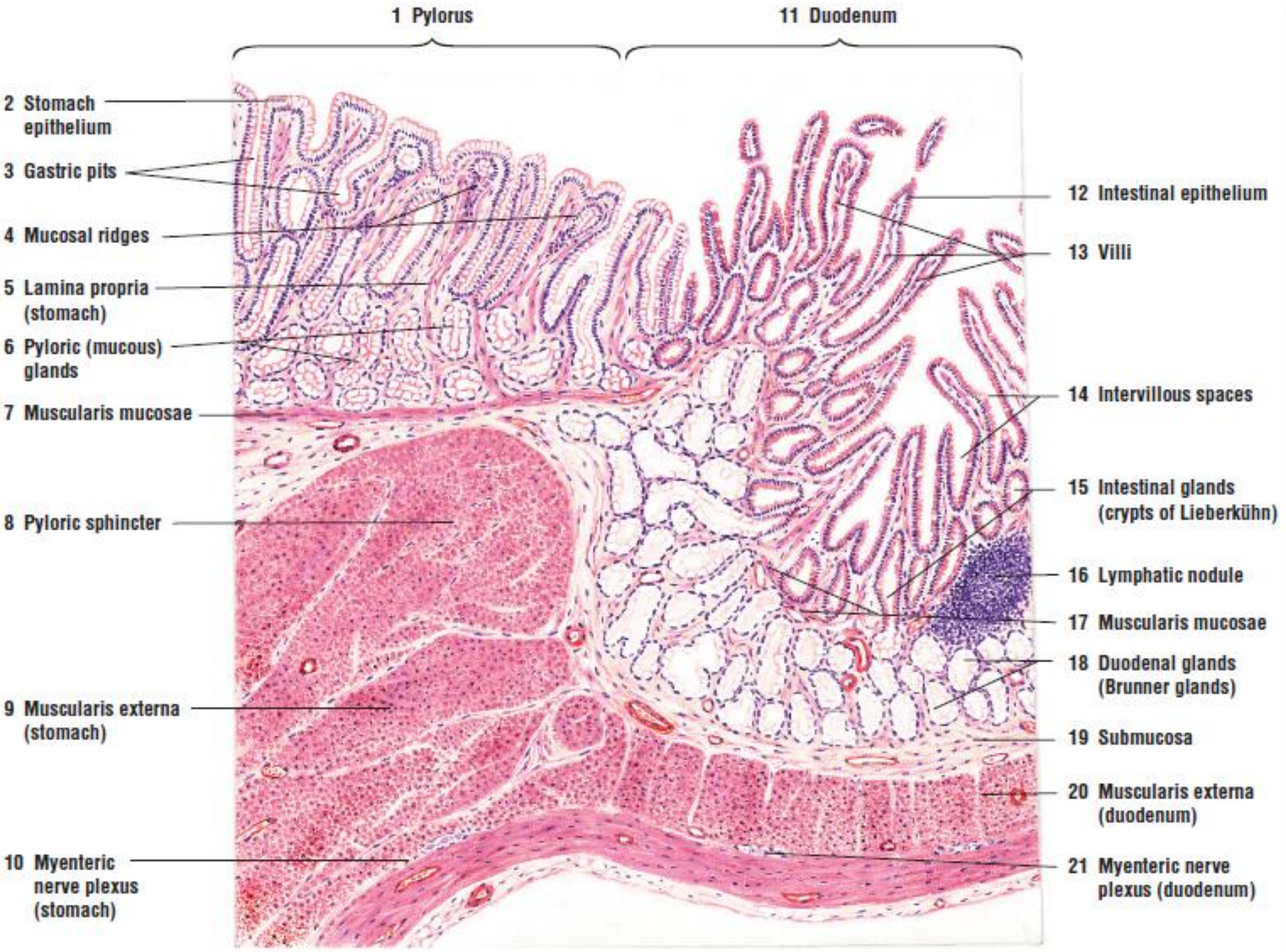


FIGURE 14.14 ■ Pyloric–duodenal junction (longitudinal section). Stain: hematoxylin and eosin. Low magnification.

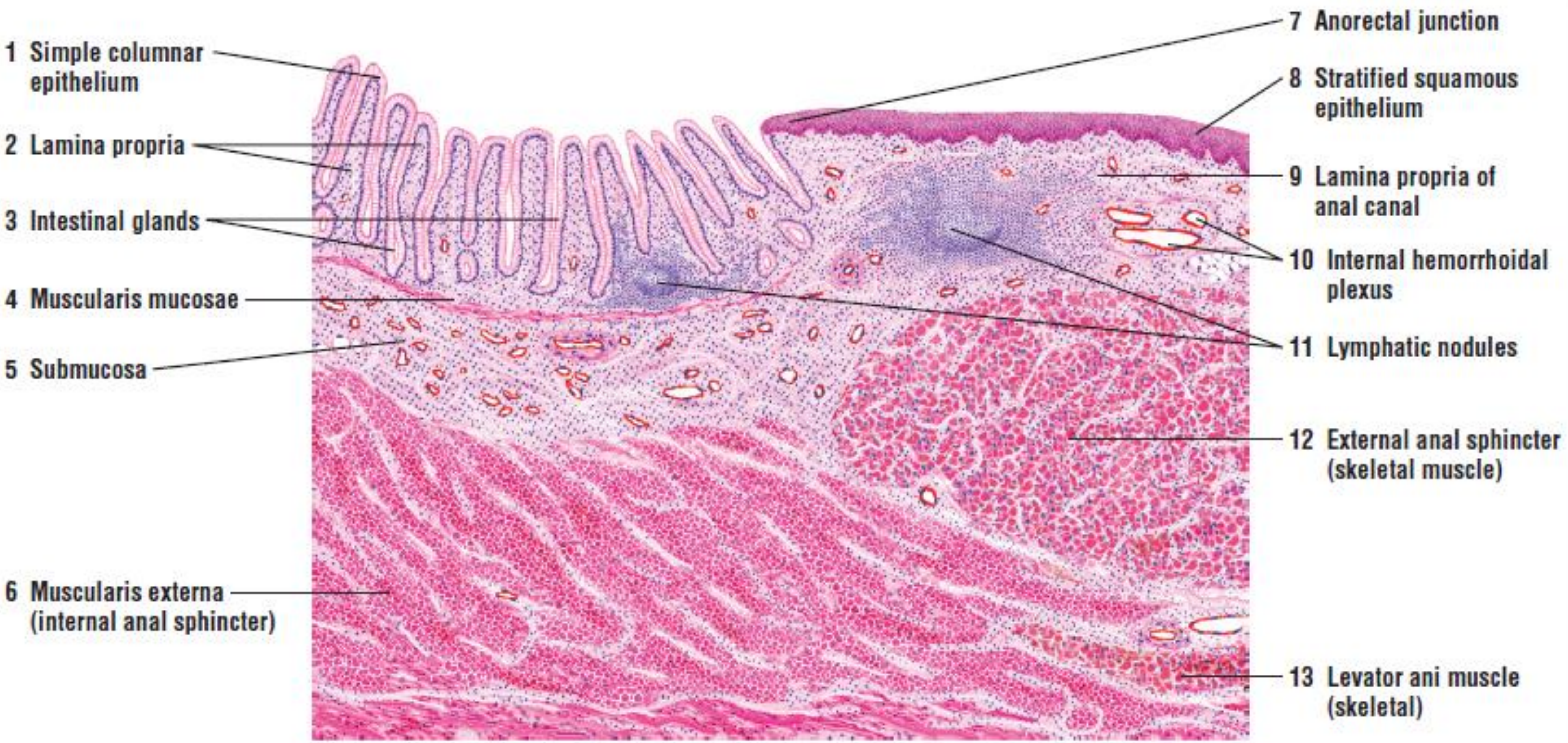
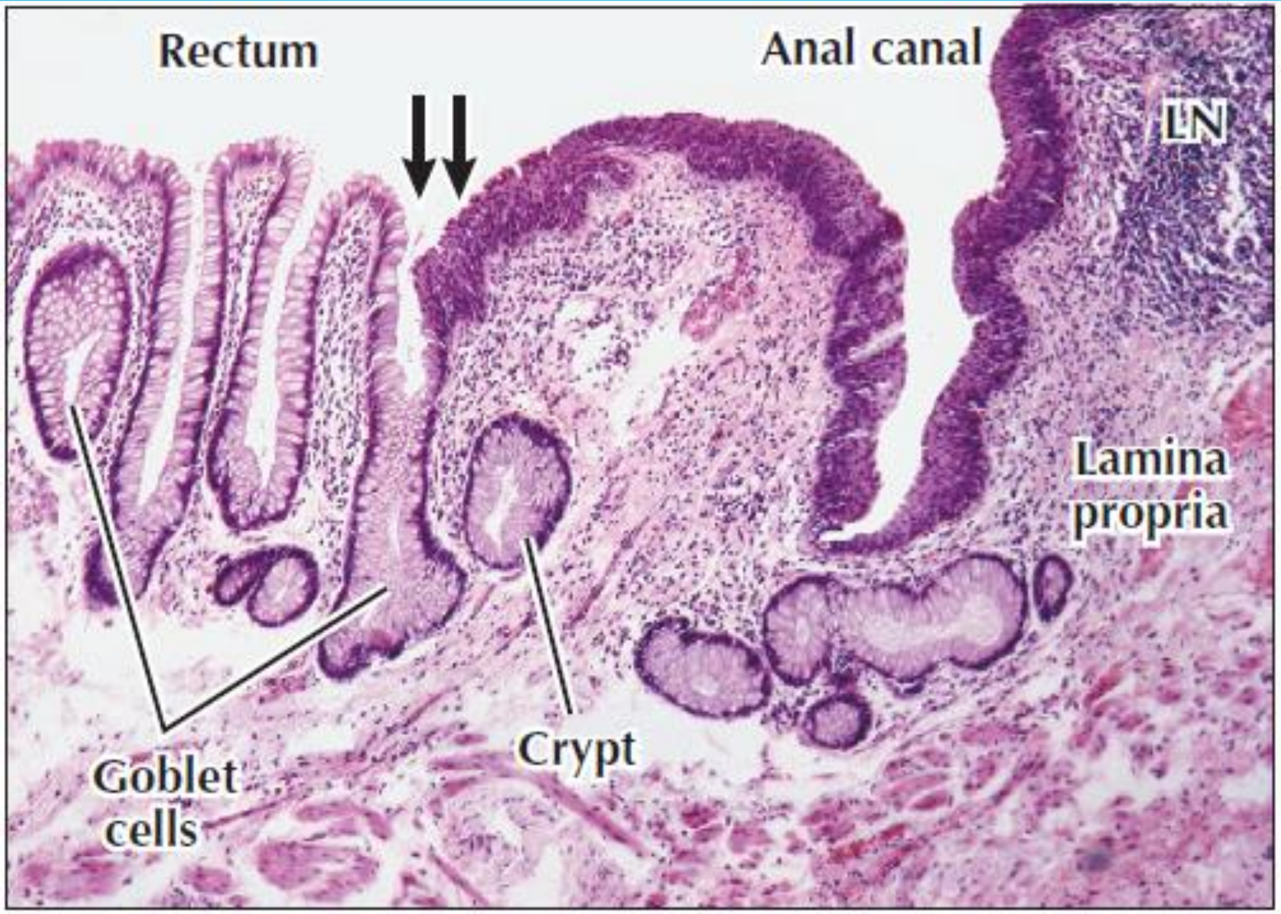
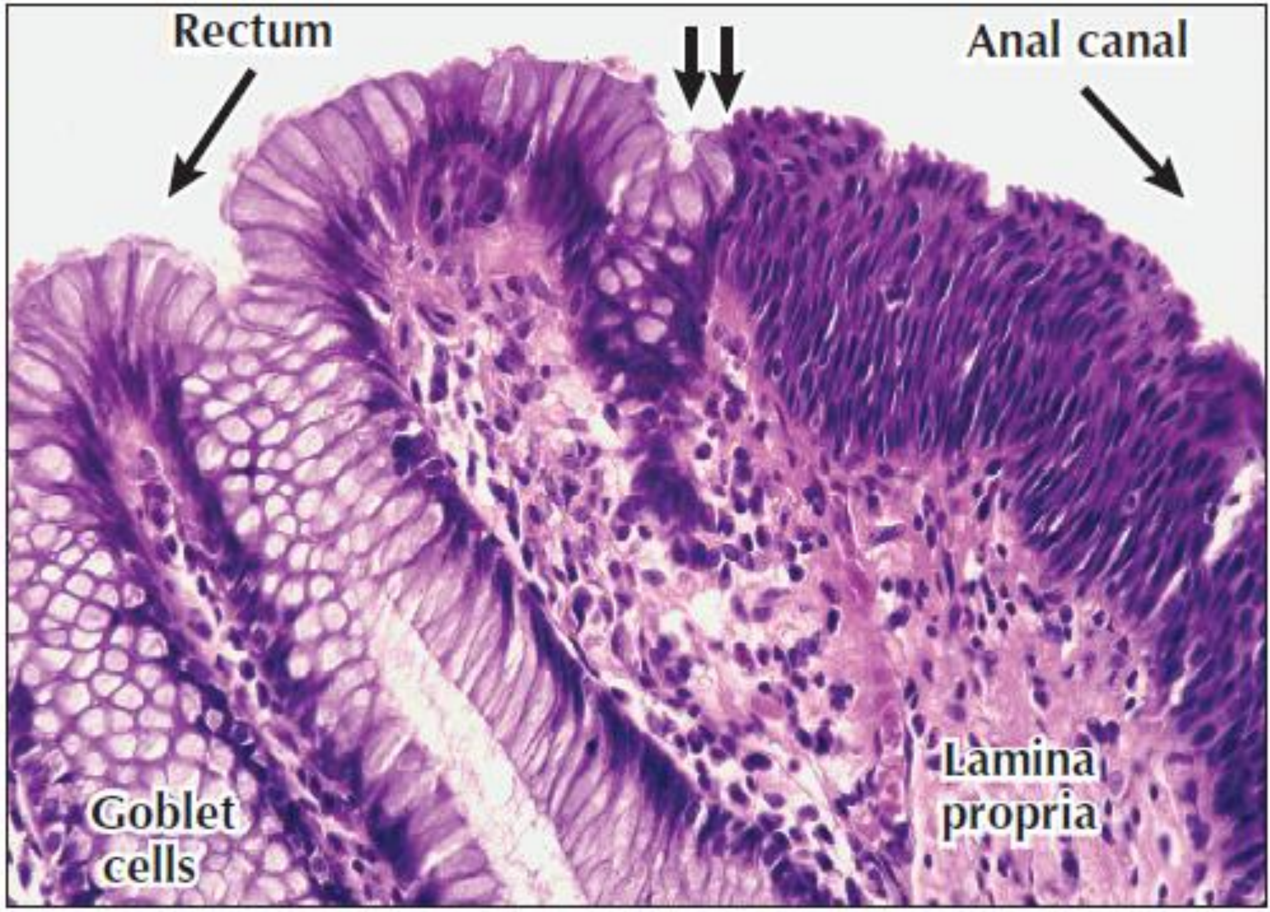


FIGURE 15.14 ■ Anorectal junction (longitudinal section). Stain: hematoxylin and eosin. Low magnification.

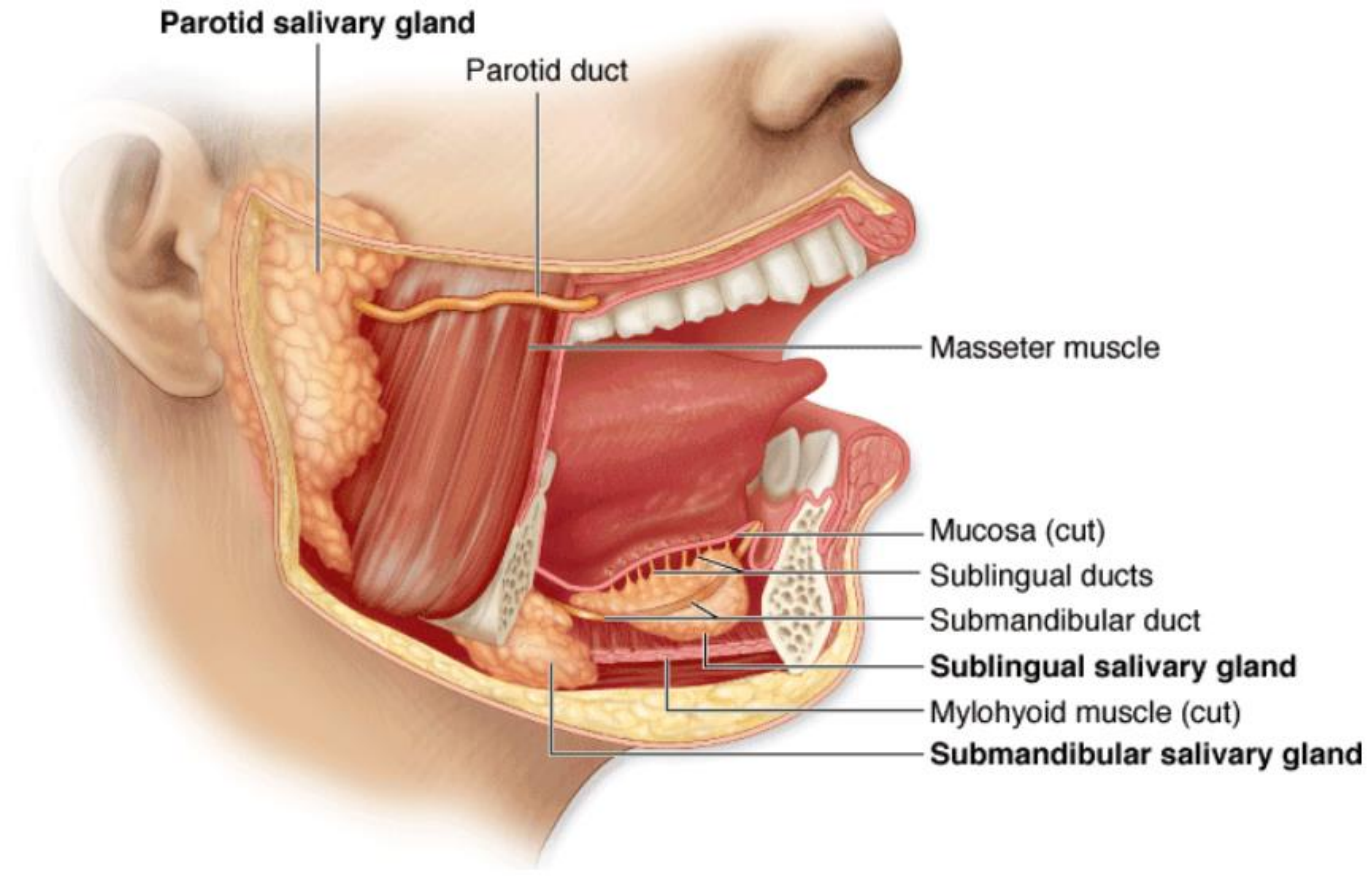




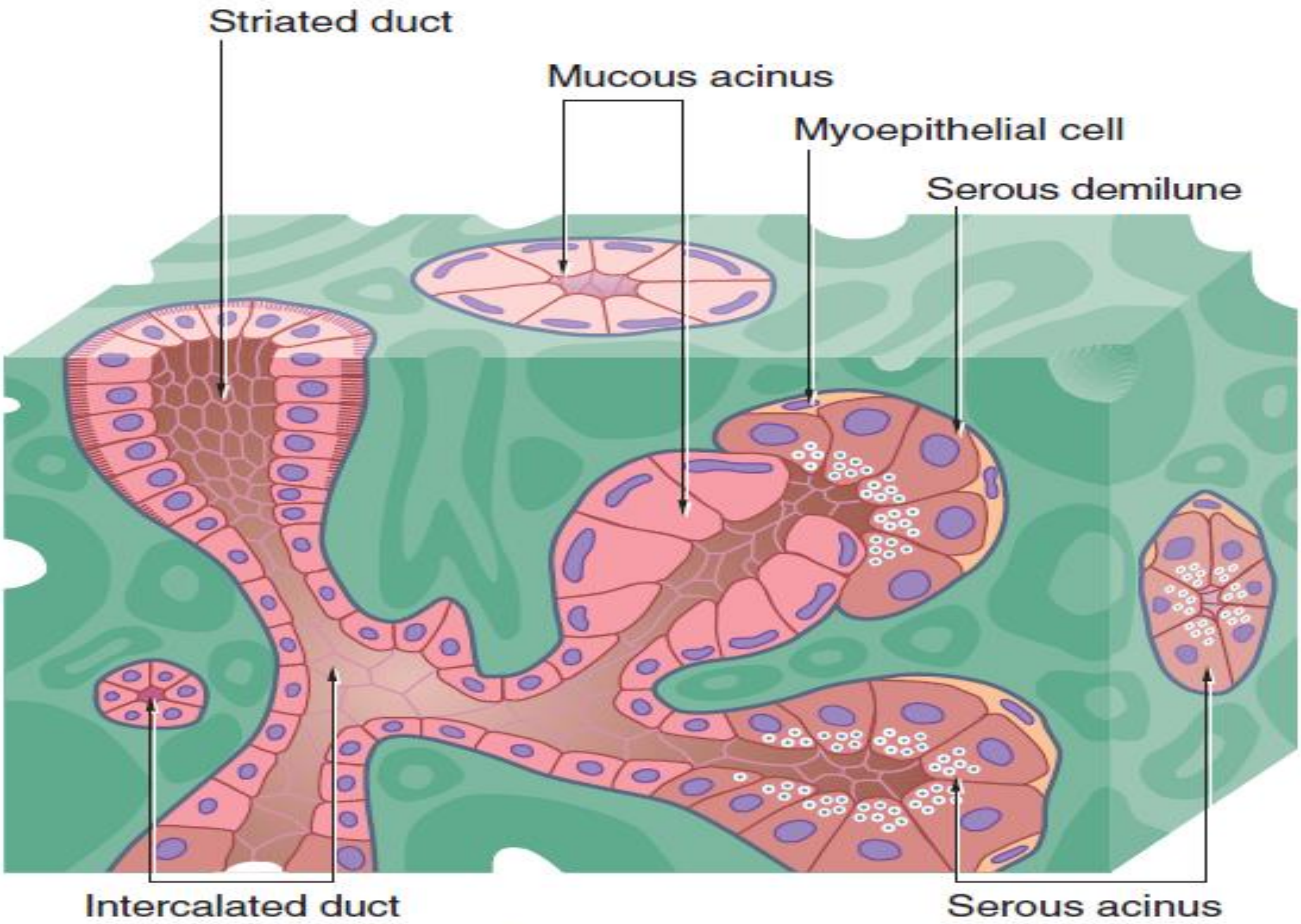
LMs of the anorectal junction at low (Left) and high (Right) magnifications

An abrupt transition (**double arrows**) from simple columnar (left) to stratified columnar (right) epithelium occurs in this part of the pectinate line. Mucus-secreting goblet cells predominate on the mucosal surface and in rectal crypts. Highly cellular lamina propria under the epithelium contains lymphoid nodules .

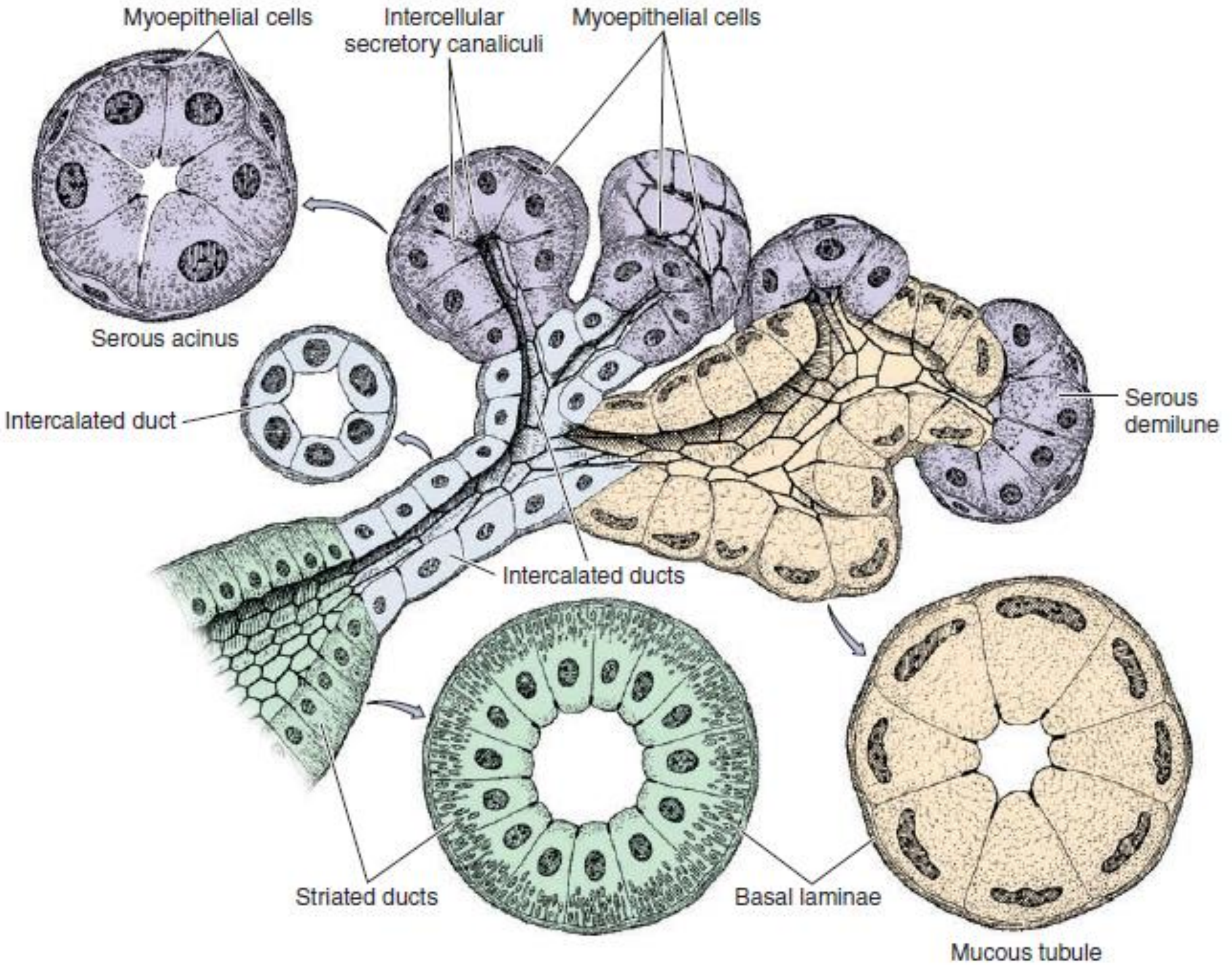
THE SALIVARY GLANDS



MAJOR SALIVARY GLANDS



SALIVARY SECRETORY UNIT



The secretory portions are composed of pyramidal serous (violet) and mucous (tan) cells. **Serous cells** are typical protein-secreting cells, with rounded nuclei, accumulation of rough ER in the basal third, and an apex filled with protein-rich secretory granules. The nuclei of **mucous cells**, flattened with condensed chromatin, are located near the bases of the cells.

The short intercalated ducts are lined with cuboidal epithelium. The **striated ducts** are composed of columnar cells with characteristics of ion-transporting cells: basal membrane invaginations with mitochondrial accumulations. **Myoepithelial cells** are shown around the serous acini.

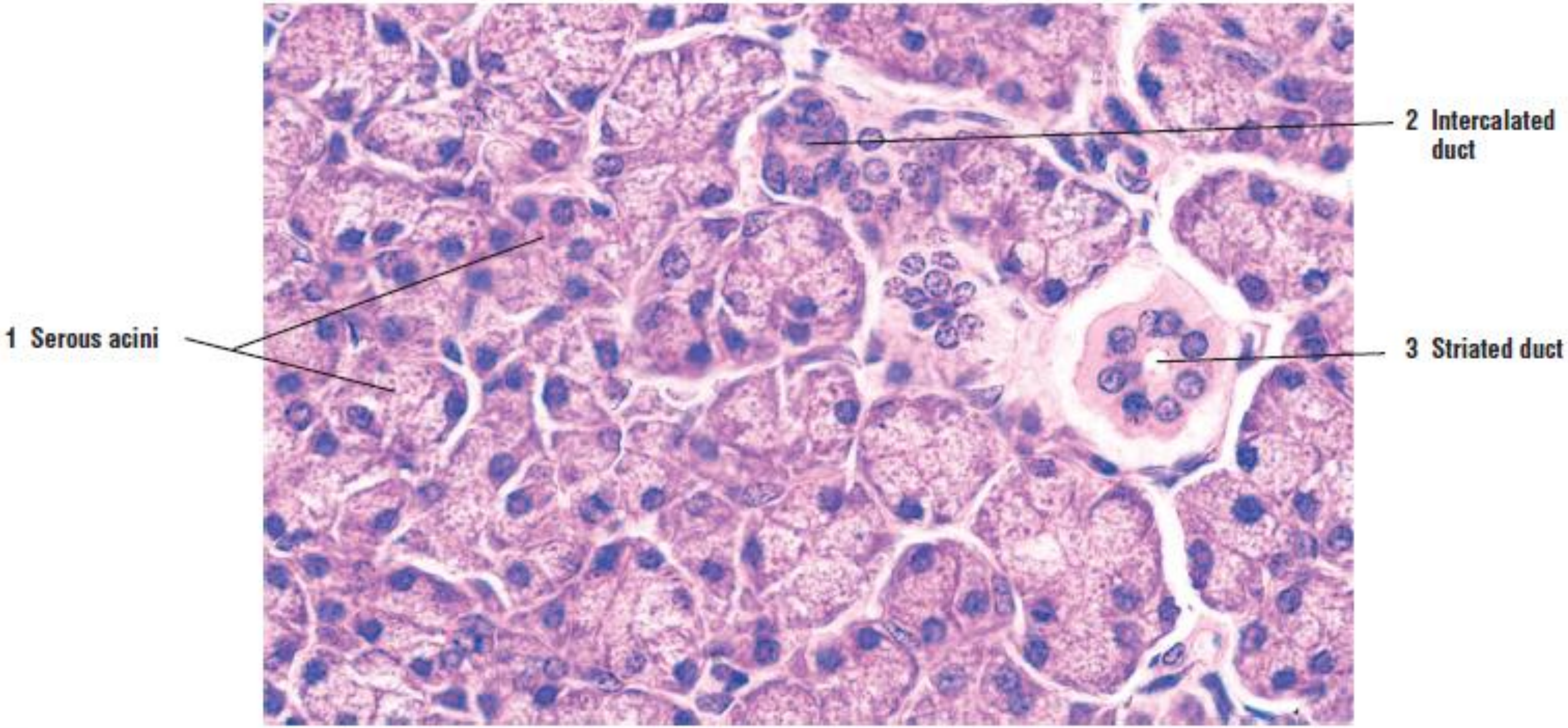


FIGURE 13.16 ■ Serous salivary gland: parotid gland. Stain: hematoxylin and eosin. ×165.

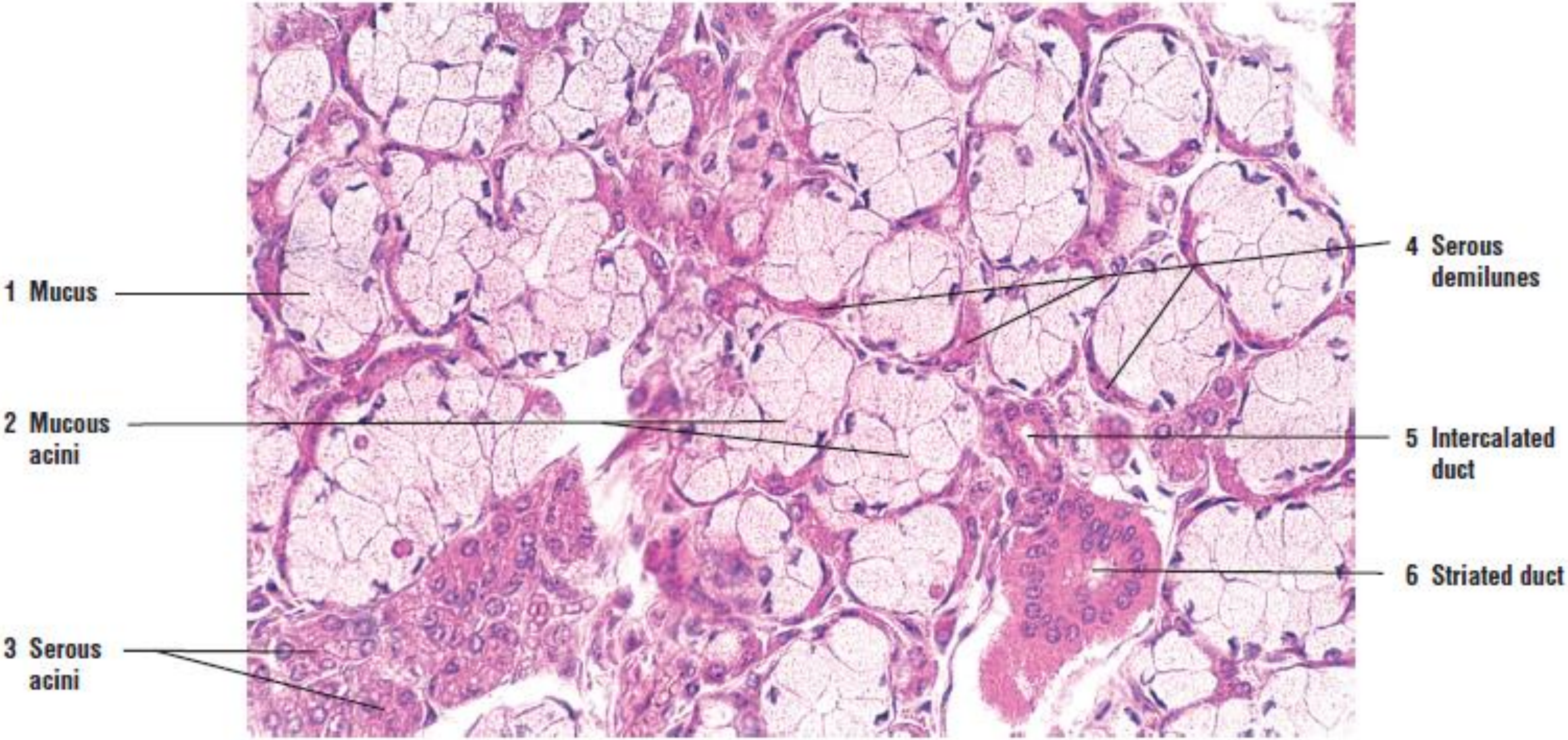


FIGURE 13.17 ■ Mixed salivary gland: sublingual gland. Stain: hematoxylin and eosin. ×165.

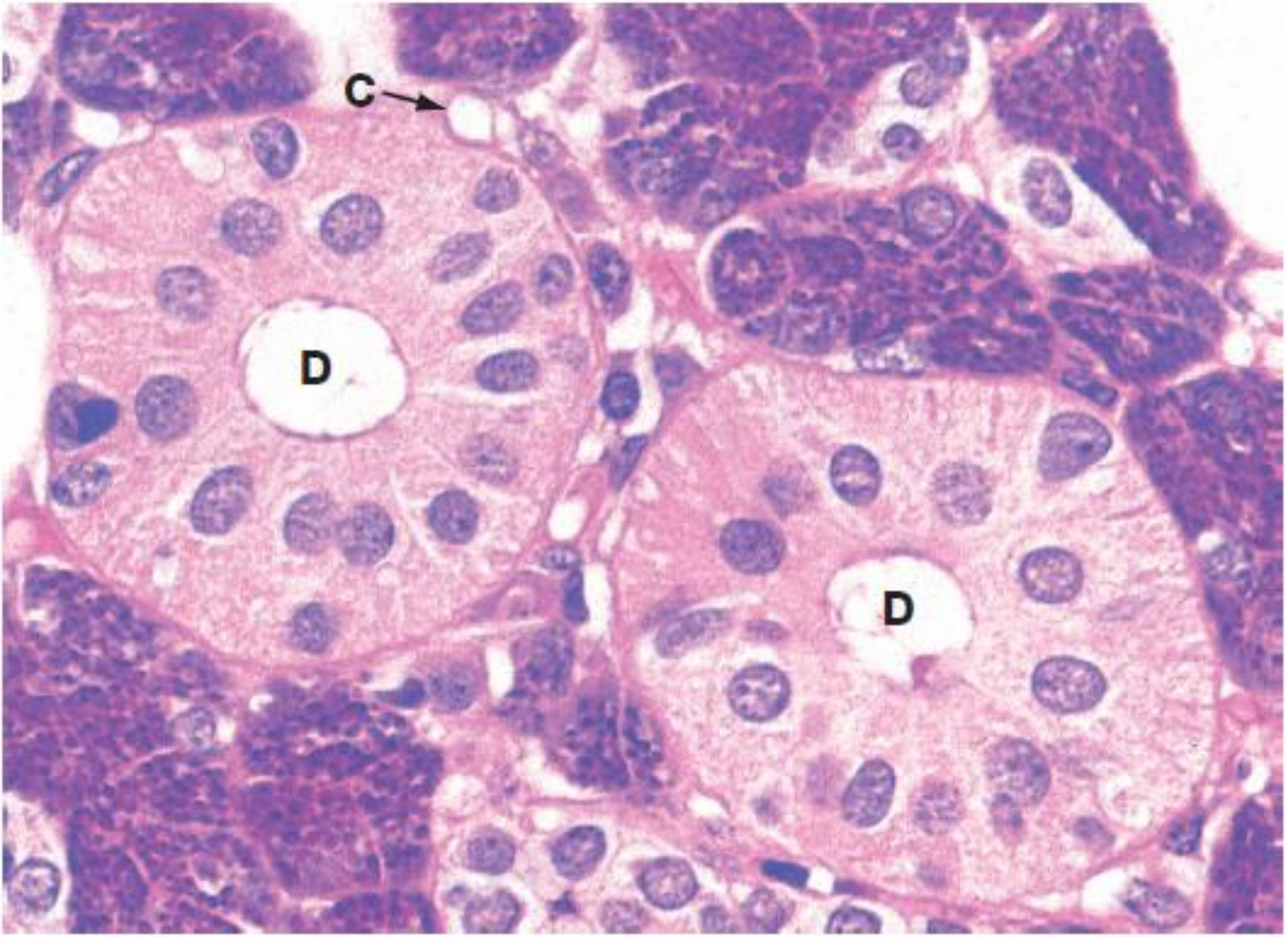


FIG. 13.17 Striated ducts
H&E (HP)

The striated ducts **D** are lined by tall columnar cells with large nuclei located towards the apex of the cell. The basal cytoplasm appears striated, reflecting the presence of basal interdigitations of cytoplasmic processes of adjacent cells and associated columns of mitochondria. This feature greatly extends the area of membrane available for exchange of water and ions, in a similar fashion to the proximal convoluted tubule of the kidney (see Fig. 16.17). The duct epithelium also secretes lysozyme and immunoglobulin (Ig)A. In predominantly serous salivary glands, the striated ducts are larger than in predominantly mucous glands, a feature associated with the role of the striated duct in modifying isotonic basic saliva to produce hypotonic saliva. The sparse supporting tissue between the secretory acini contains a rich network of capillaries **C**.

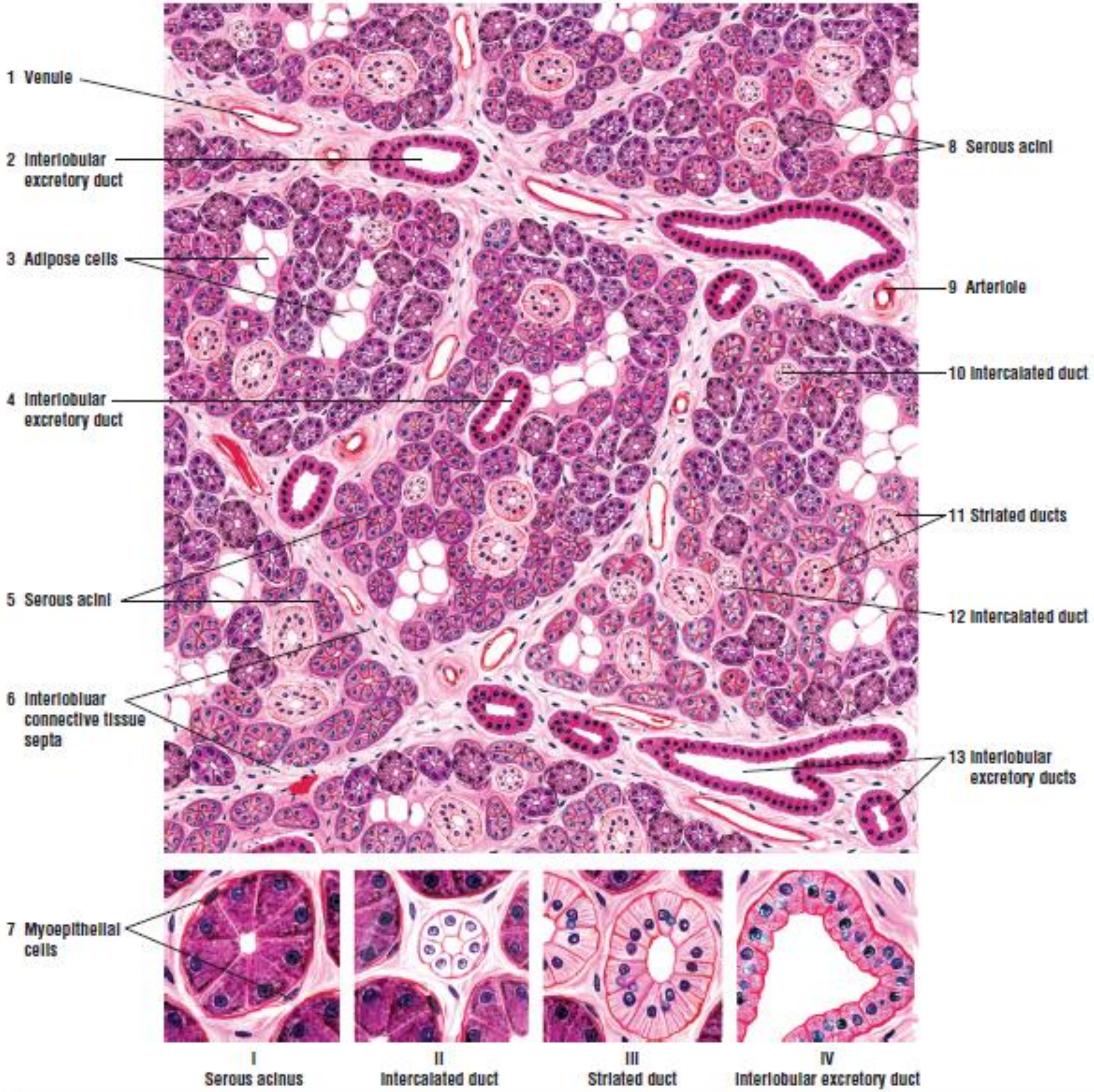


FIGURE 13.13 ■ Parotid salivary gland. Stain: hematoxylin and eosin. Upper: medium magnification. Lower: high magnification.

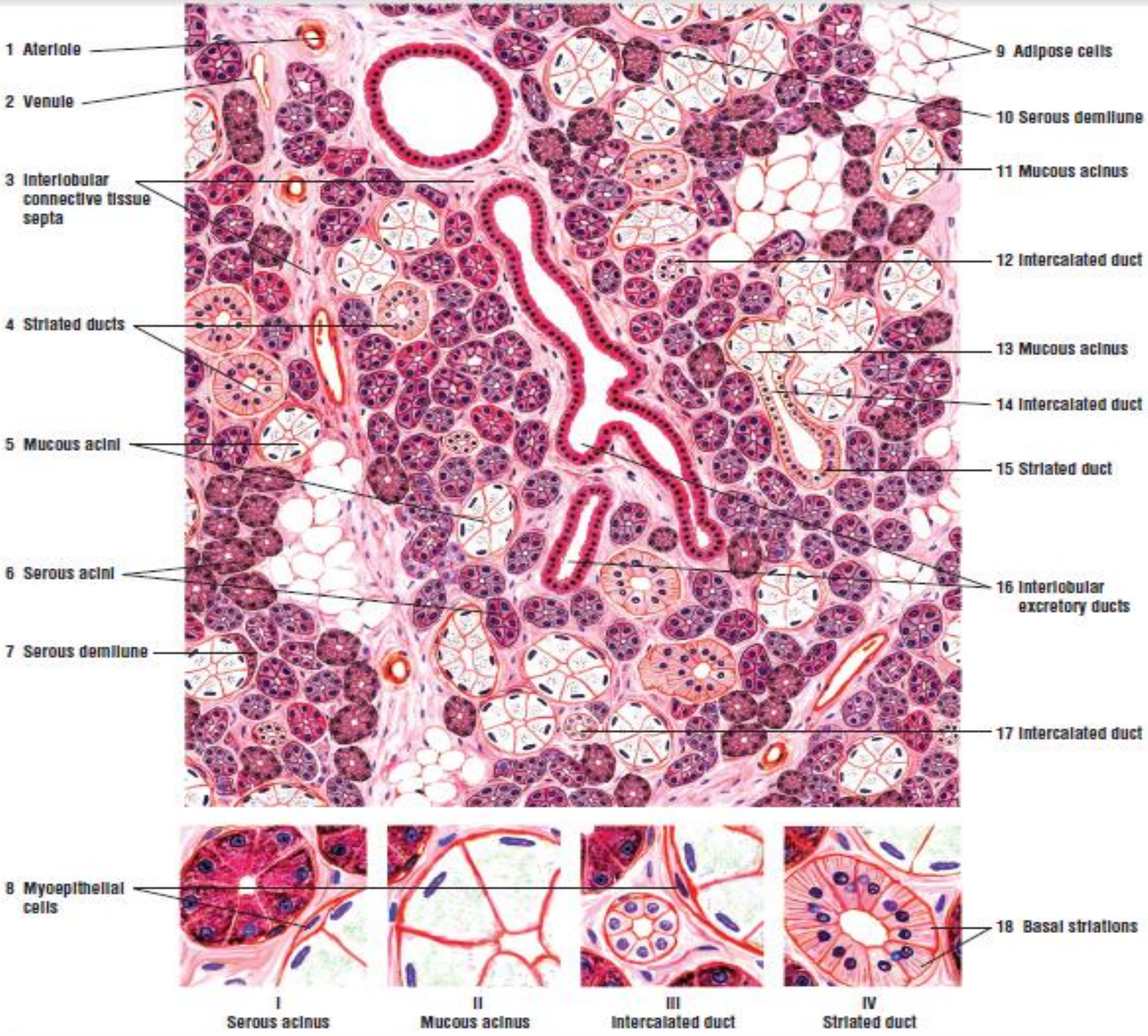


FIGURE 13.14 ■ Submandibular salivary gland. Stain: hematoxylin and eosin. Upper: medium magnification. Lower: high magnification.

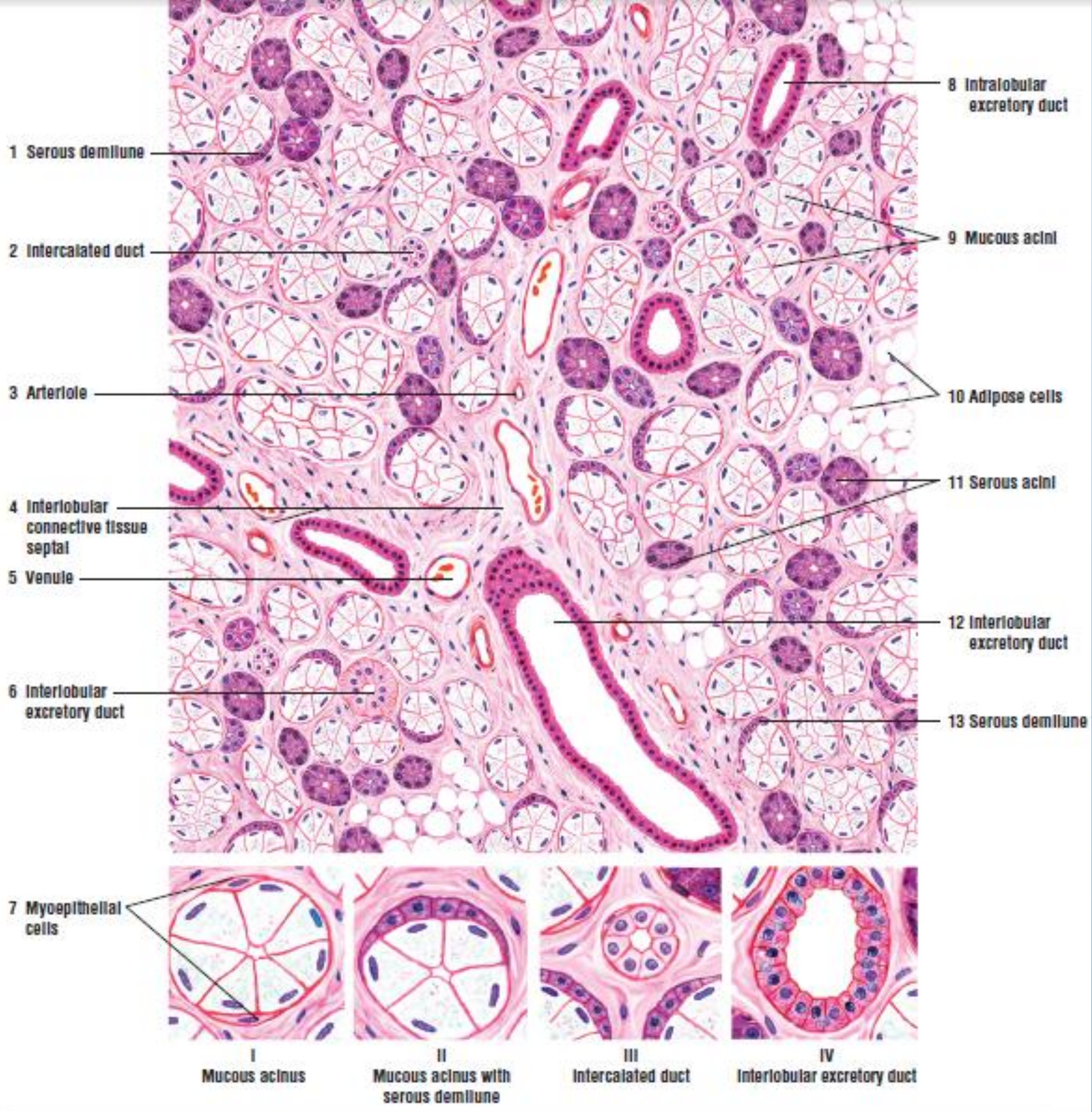
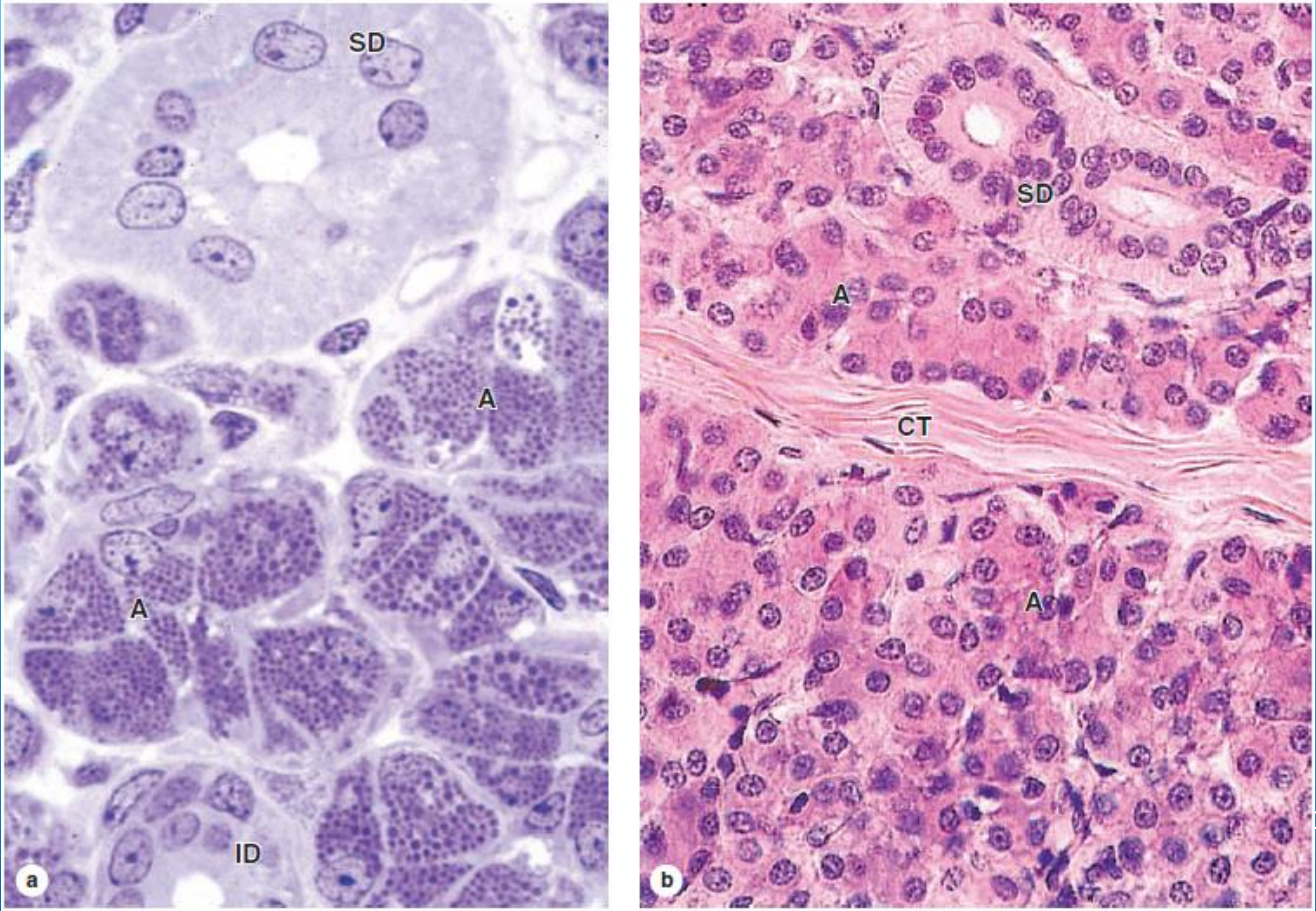


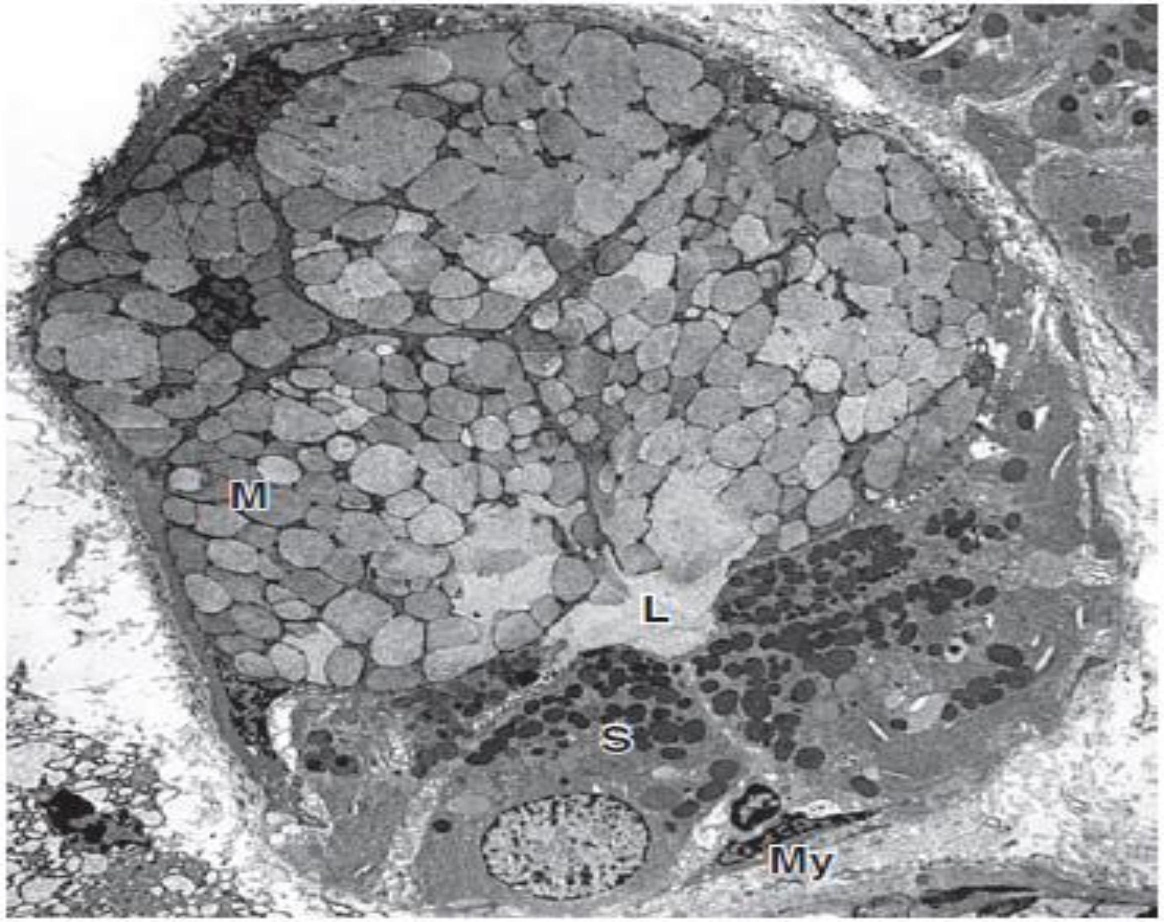
FIGURE 13.15 ■ Sublingual salivary gland. Stain: hematoxylin and eosin. Upper: medium magnification. Lower: high magnification.



The large parotid gland consists entirely of serous acini with cells producing amylase and other proteins for storage in secretory granules. **(a)** Micrograph of a parotid gland shows densely packed serous acini (**A**) with ducts. Secretory granules of serous cells are clearly shown in this plastic section, as well as an intercalated duct (**ID**) and striated duct (**SD**), both cut transversely. X400. PT.

(b) Striations of a duct (**SD**) are better seen here, along with a septum (**CT**) and numerous serous acini (**A**). The connective tissue often includes adipocytes. X200. H&E.

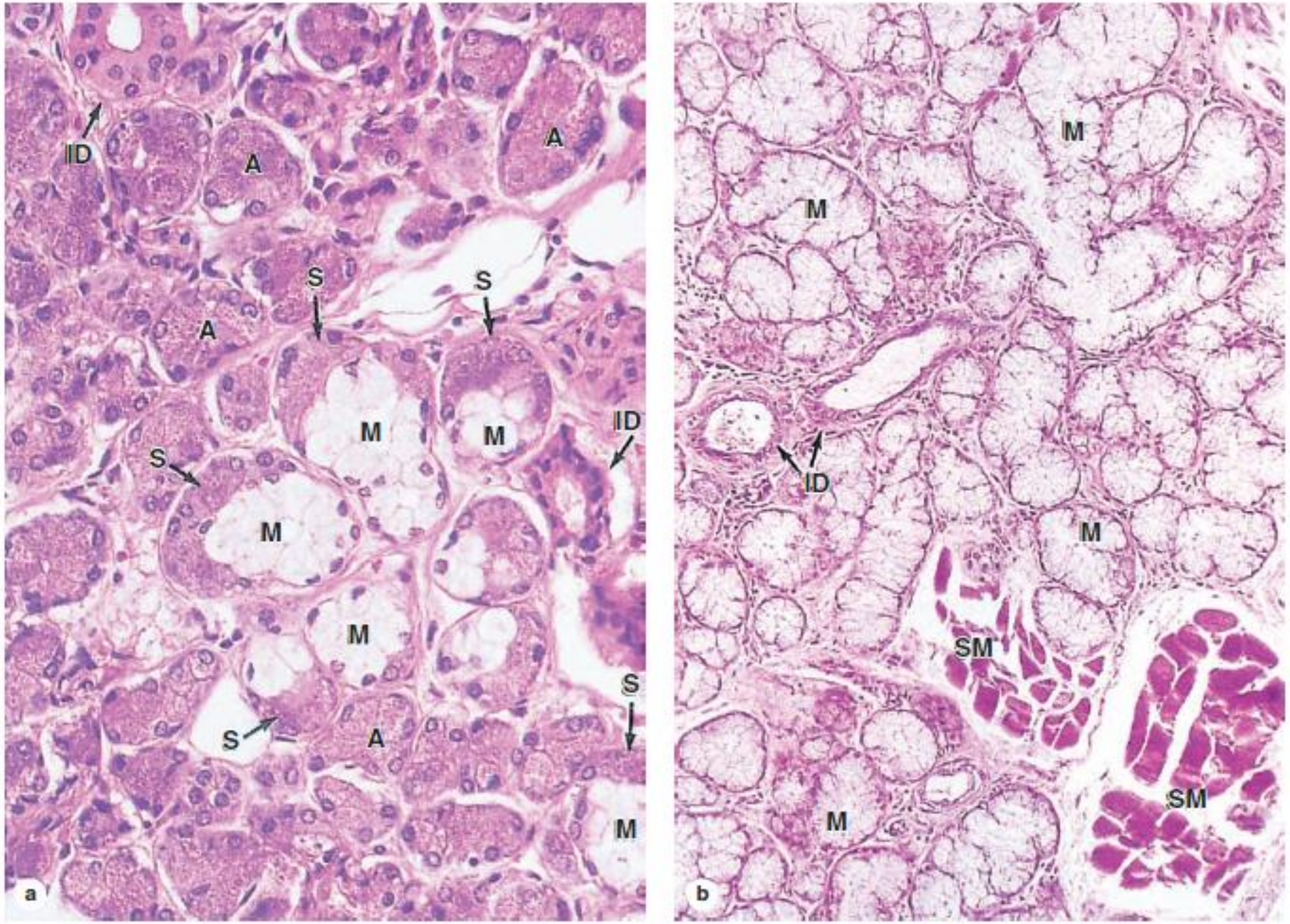
FIGURE **16–4** **Ultrastructure of serous and mucous cells.**



A micrograph of a mixed acinus from a submandibular gland shows both serous and mucous cells surrounding the small lumen (**L**). Mucous cells (**M**) have large, hydrophilic granules like those of goblet cells, while serous cells (**S**) have small, dense granules. Small myoepithelial cells (**My**) extend contractile processes around each acinus. X2500.

(*With permission, from Dr John D. Harrison, King's College London Dental Institute, London, UK.*)

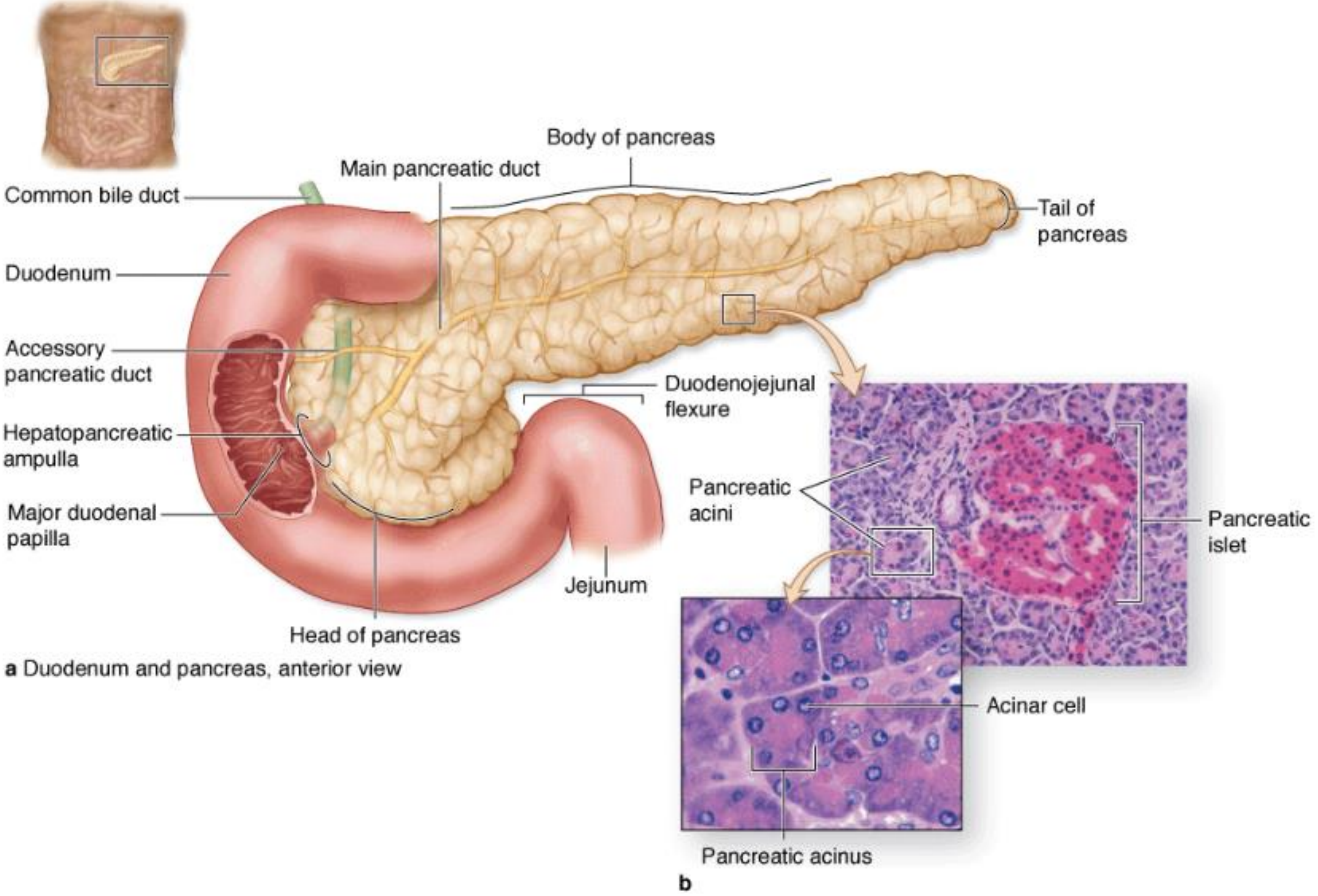
FIGURE **16–5** **Submandibular gland and sublingual gland.**



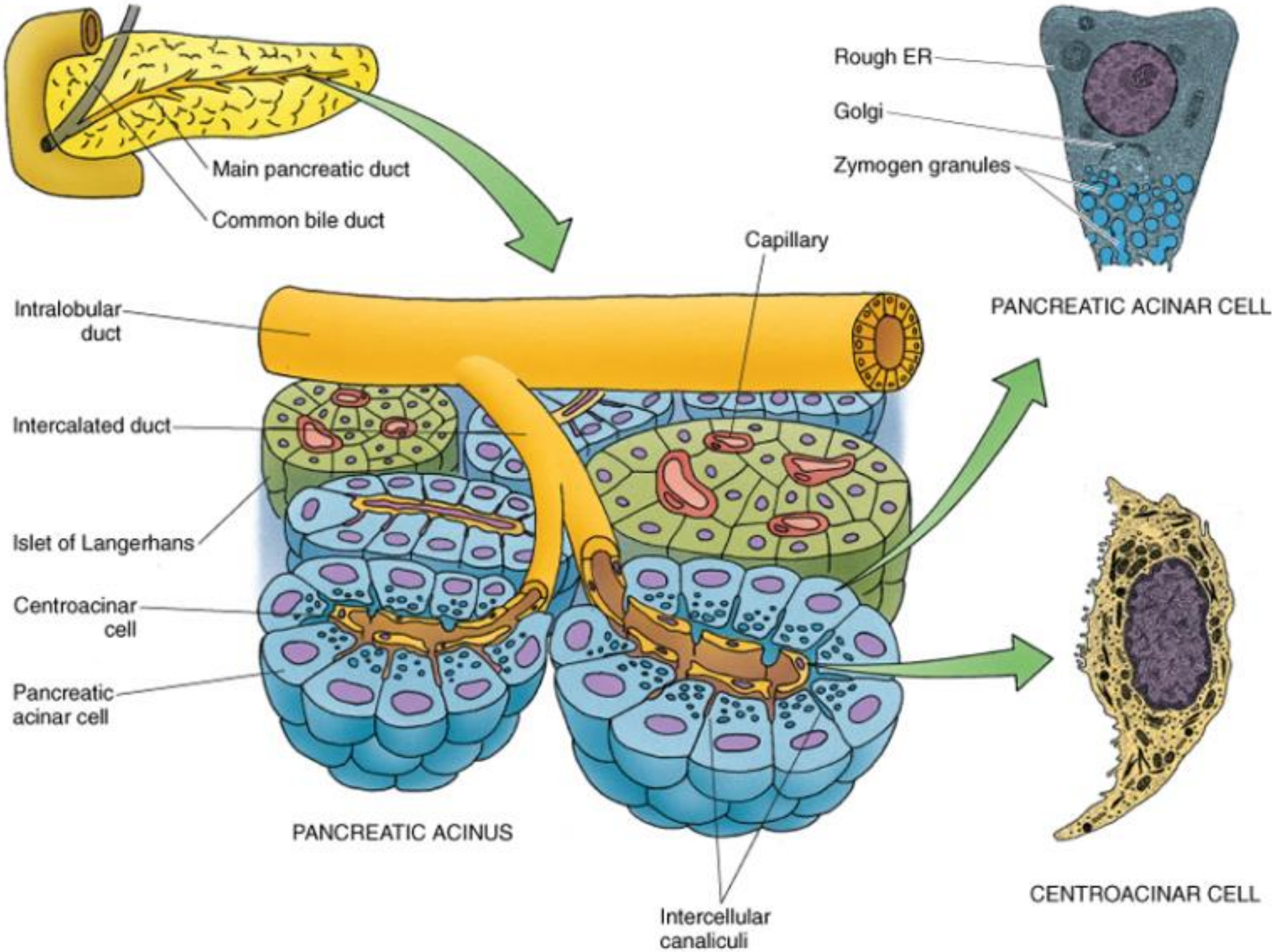
(a) The submandibular gland is a mixed serous and mucous gland (serous cells predominate), and shows well-stained serous acini (**A**) and serous demilunes (**S**) and pale-staining mucous cells (**M**) grouped as tubules in this tubuloacinar gland. Small intralobular ducts (**ID**) drain each lobule. X340. H&E.

(b) The sublingual gland is a mixed but largely mucous gland with a tubuloacinar arrangement of poorly stained mucous cells (**M**). Small intralobular ducts (**ID**) are seen in connective tissue, as well as small fascicles of lingual striated muscle (**SM**). X140. H&E.

THE PANCREAS

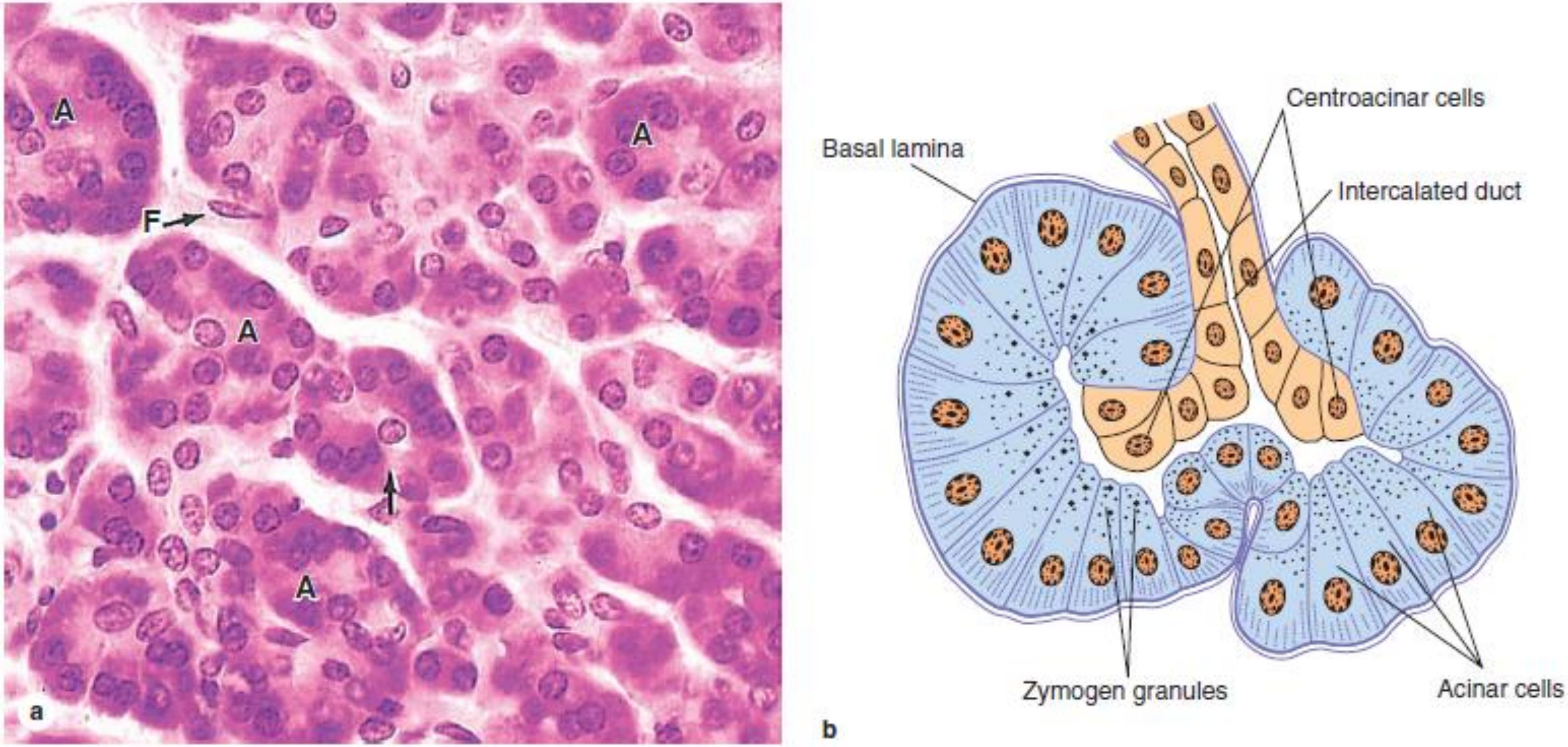


a Duodenum and pancreas, anterior view



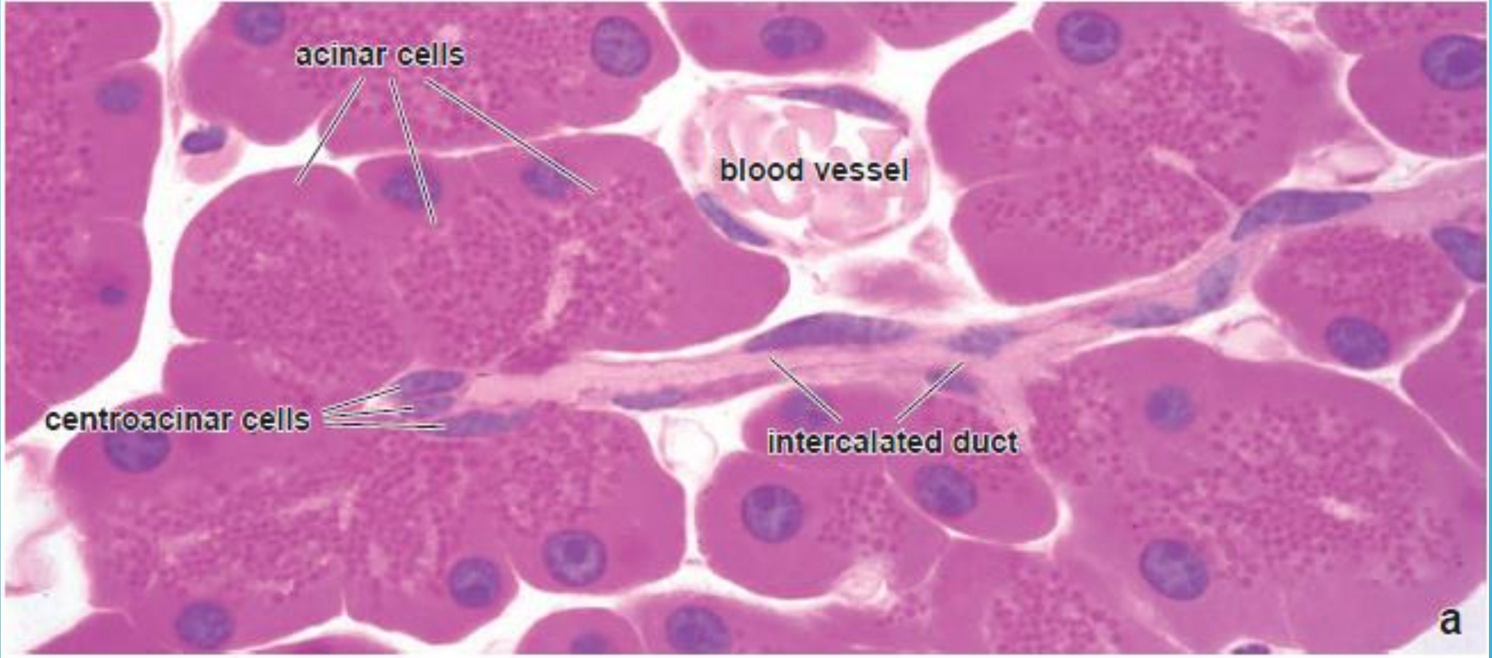
Main pancreatic duct
Common bile duct
Rough ER
Golgi
Zymogen granules
PANCREATIC ACINAR CELL
Capillary
Intralobular duct
Intercalated duct
Islet of Langerhans
Centroacinar cell
Pancreatic acinar cell
PANCREATIC ACINUS
Intercellular canaliculi
CENTROACINAR CELL

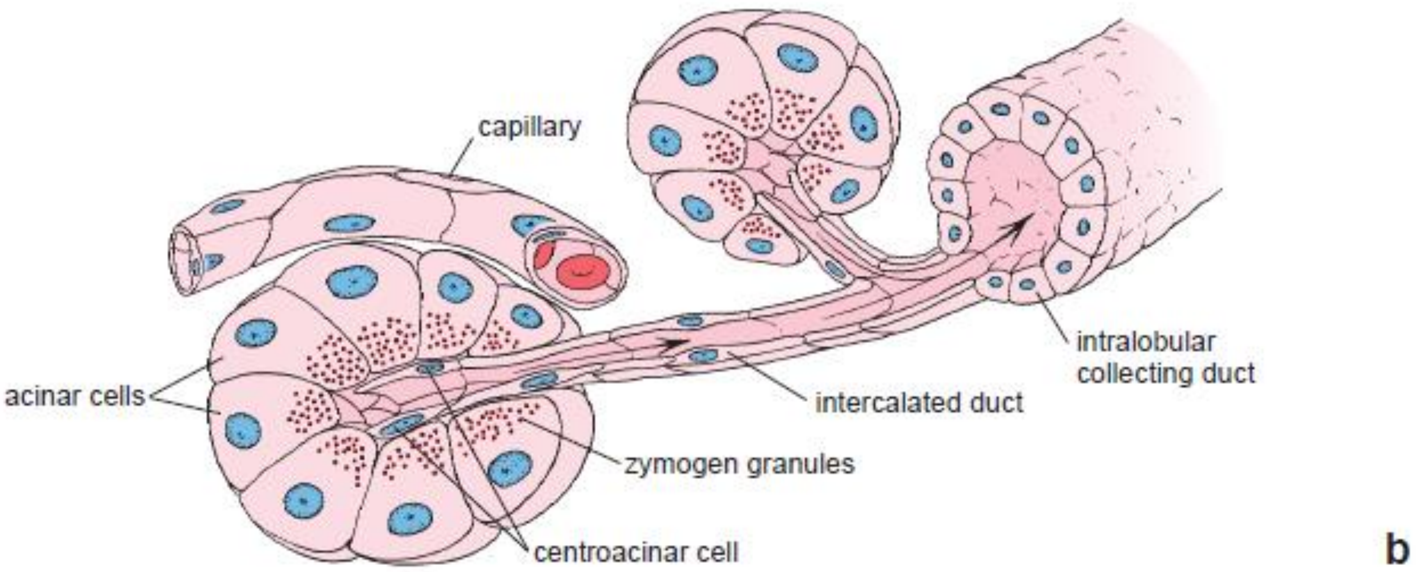
FIGURE **16–9** **Pancreatic acini.**



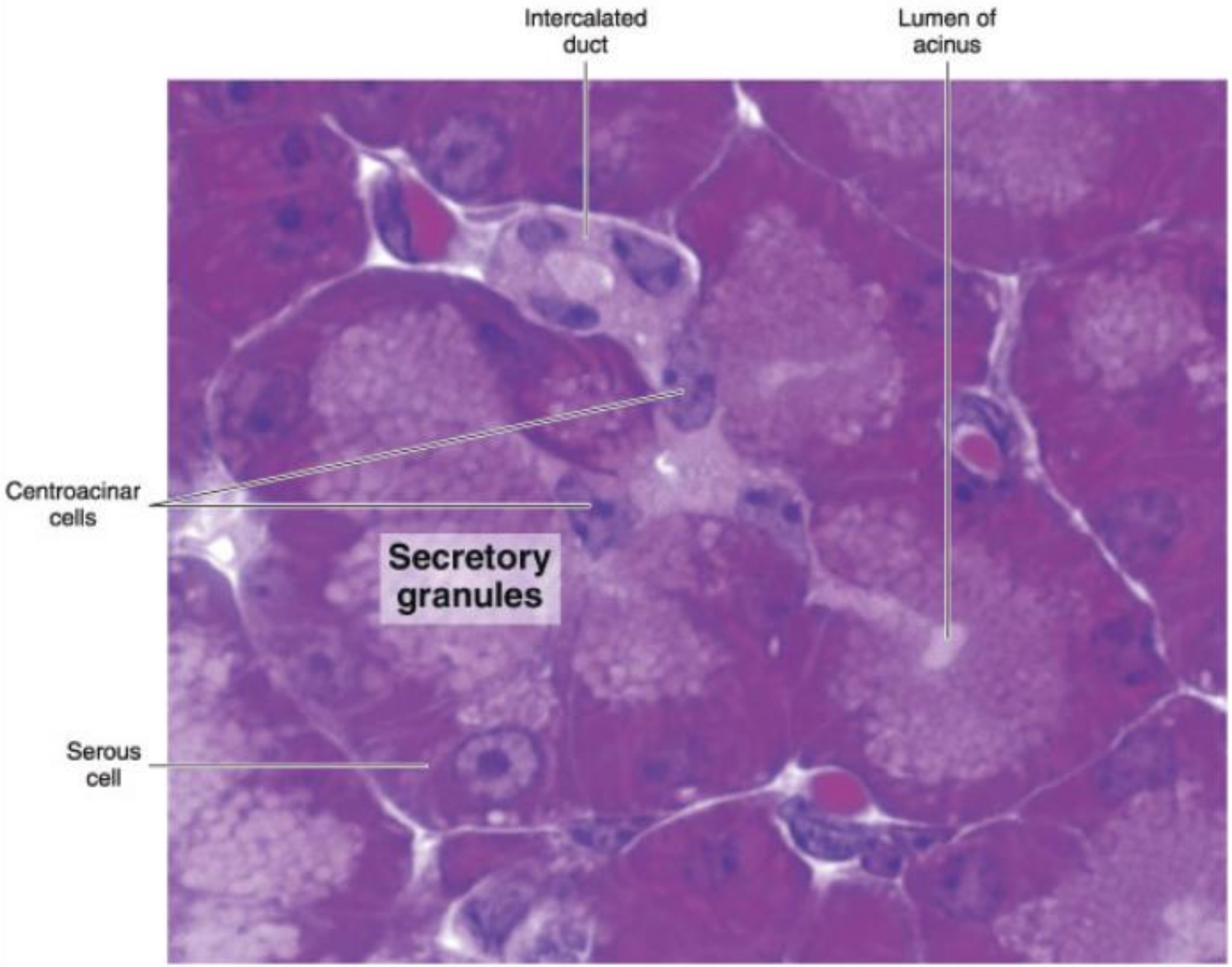
(a) Micrograph of exocrine pancreas shows the serous, enzyme-producing cells arranged in small acini (**A**) with very small lumens. Acini are surrounded by only small amounts of connective tissue with fibroblasts (**F**). Each acinus is drained by an intercalated duct with its initial cells, the centroacinar cells (**arrow**), inserted into the acinar lumen. X200. H&E.

(b) The diagram shows the arrangement of cells more clearly. Under the influence of secretin, the **centroacinar** and **intercalated duct cells** secrete a copious HCO_3^--rich fluid that hydrates, flushes, and alkalinizes the enzymatic secretion of the acini.

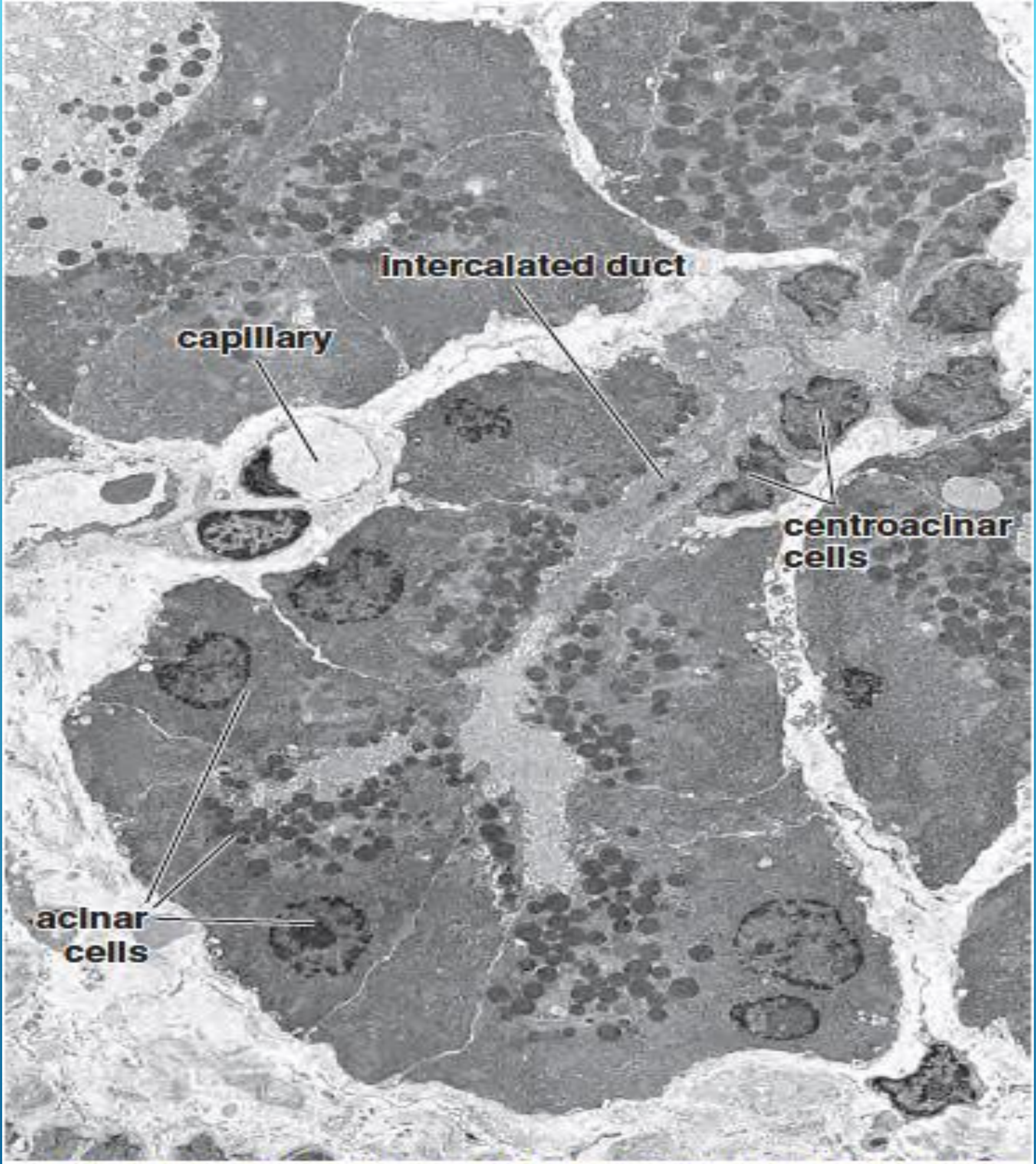




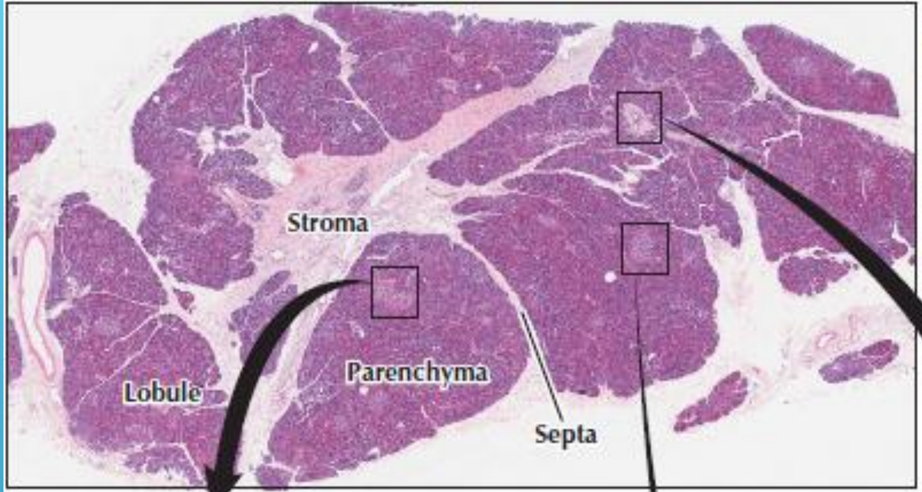
PANCREATIC ACINUS AND ITS DUCT SYSTEM



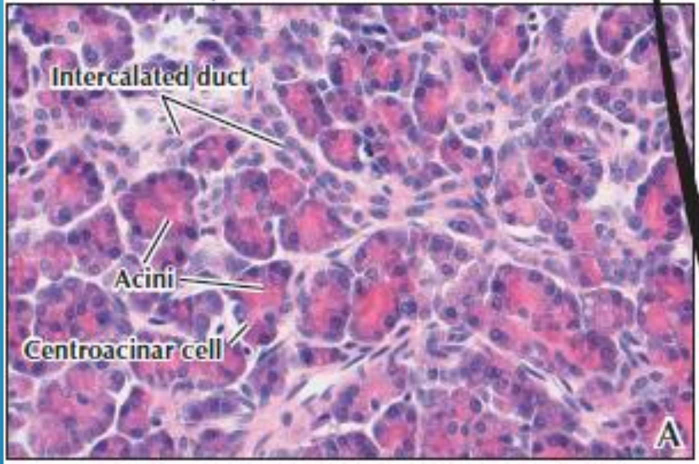
Section of the exocrine pancreas showing its main components. PT stain. Medium magnification.

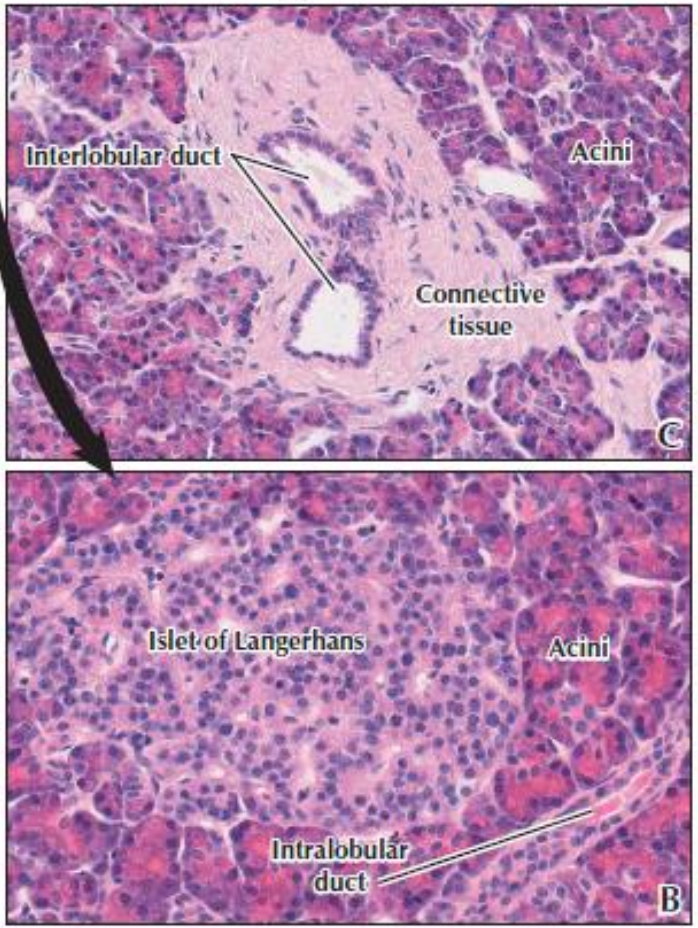


Electron micrograph of the pancreatic acinus and intercalated duct



◄ **LM of the pancreas at low magnification.** Intensely stained parenchyma of the gland is organized into lobules. More lightly stained stroma consists mainly of connective tissue. Thumbnail areas in the three boxes are seen at higher magnification below, and show different parts of the excretory duct system traversing the gland. 18×. *H&E.*





▲ ► **LMs of the pancreas showing parts of the exocrine duct system.** Short, branching intercalated ducts—the initial part of the excretory duct system— drain acini and are lined by a low simple cuboidal epithelium (**A**). Longer intralobular ducts are lined by simple cuboidal epithelium consisting of more plump cells (**B**). Larger interlobular ducts are lined by simple cuboidal epithelium invested by dense fibrous connective tissue (**C**). Interlobular ducts, in turn, drain directly into the main pancreatic ducts, which deliver secretions to the duodenum. Secretory cells of acini are intensely eosinophilic, have basal nuclei, and produce digestive enzymes. Centroacinar cells protrude into the lumen of each acinus. They have clear cytoplasm, and secrete fluid rich in HCO_3^- and Na^+. Pale cells in the richly vascularized islets constitute the endocrine part of the gland. **A:** 290×; **B:** 215×; **C:** 250×. *H&E.*

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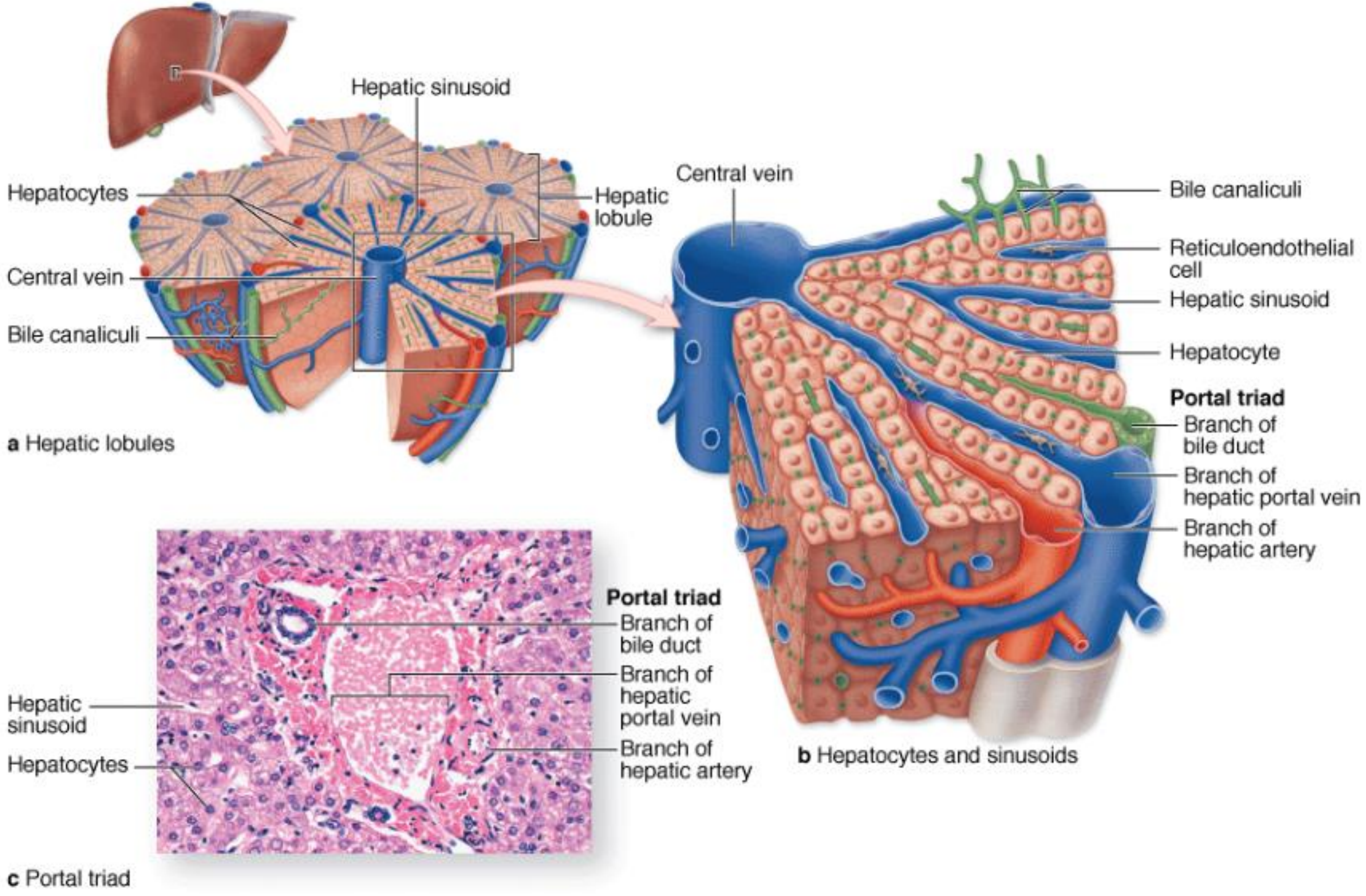
THE LIVER


Hepatic sinusoid
Hepatocytes
Hepatic lobule
Central vein
Bile canaliculi
a Hepatic lobules
Central vein
Bile canaliculi
Reticuloendothelial cell
Hepatic sinusoid
Hepatocyte
Portal triad
Branch of bile duct
Branch of hepatic portal vein
Branch of hepatic artery
b Hepatocytes and sinusoids
Portal triad
Branch of bile duct
Branch of hepatic portal vein
Branch of hepatic artery
Hepatic sinusoid
Hepatocytes
c Portal triad

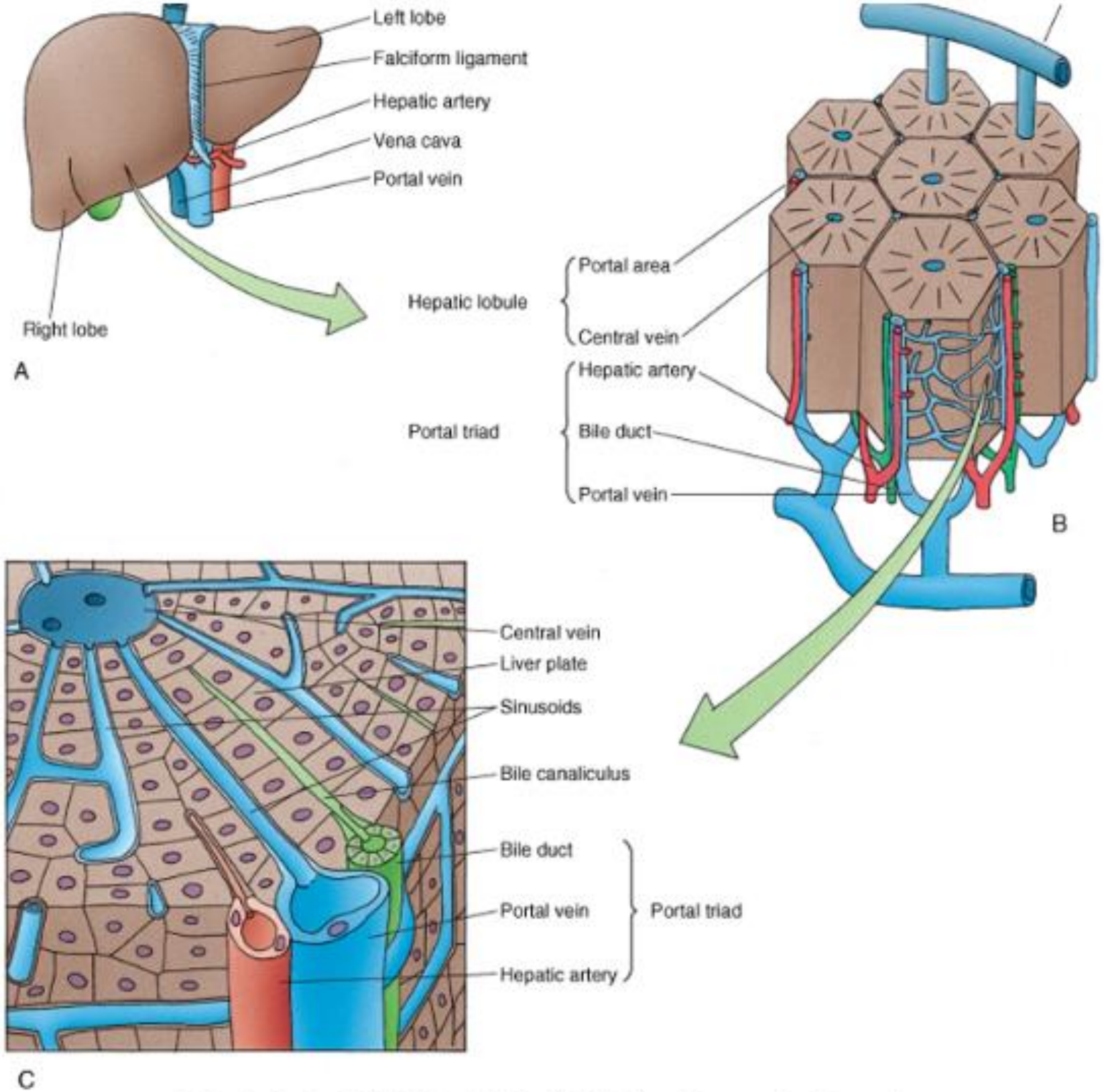


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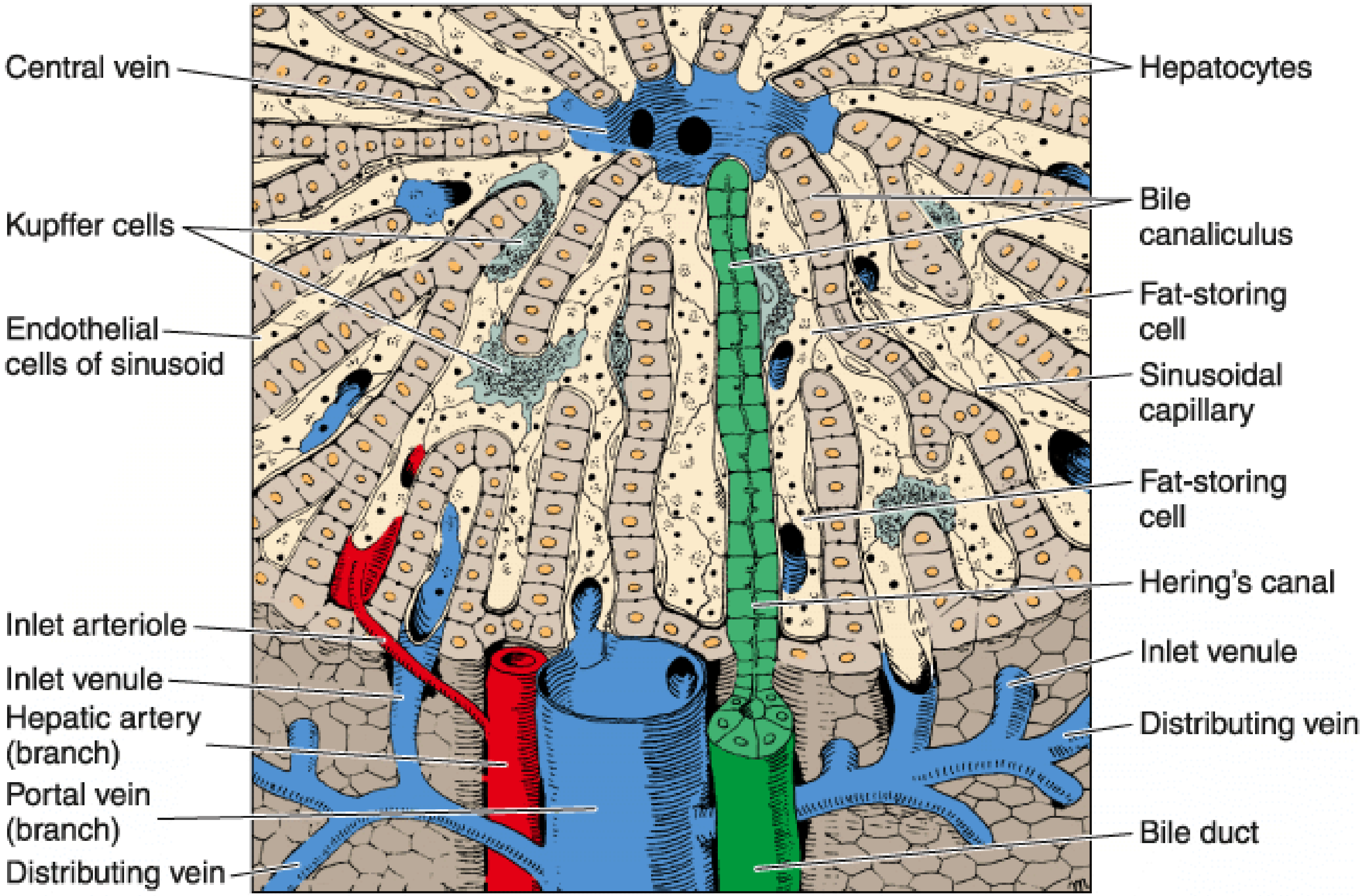
Figure 18-9 Liver. A, Gross anatomy of the liver. B, Liver lobules displaying the portal areas and the central vein. C, Portion of the liver lobule displaying the portal area, liver plates, sinusoids, and bile canaliculi.



Three-dimensional aspect of the normal liver. In the upper center is the central vein; in the lower center is the portal vein. Note the bile canaliculus, liver plates, Hering's canal, Kupffer cells, sinusoid, fat-storing cell, and sinusoid endothelial cells. (Courtesy of M Muto.)

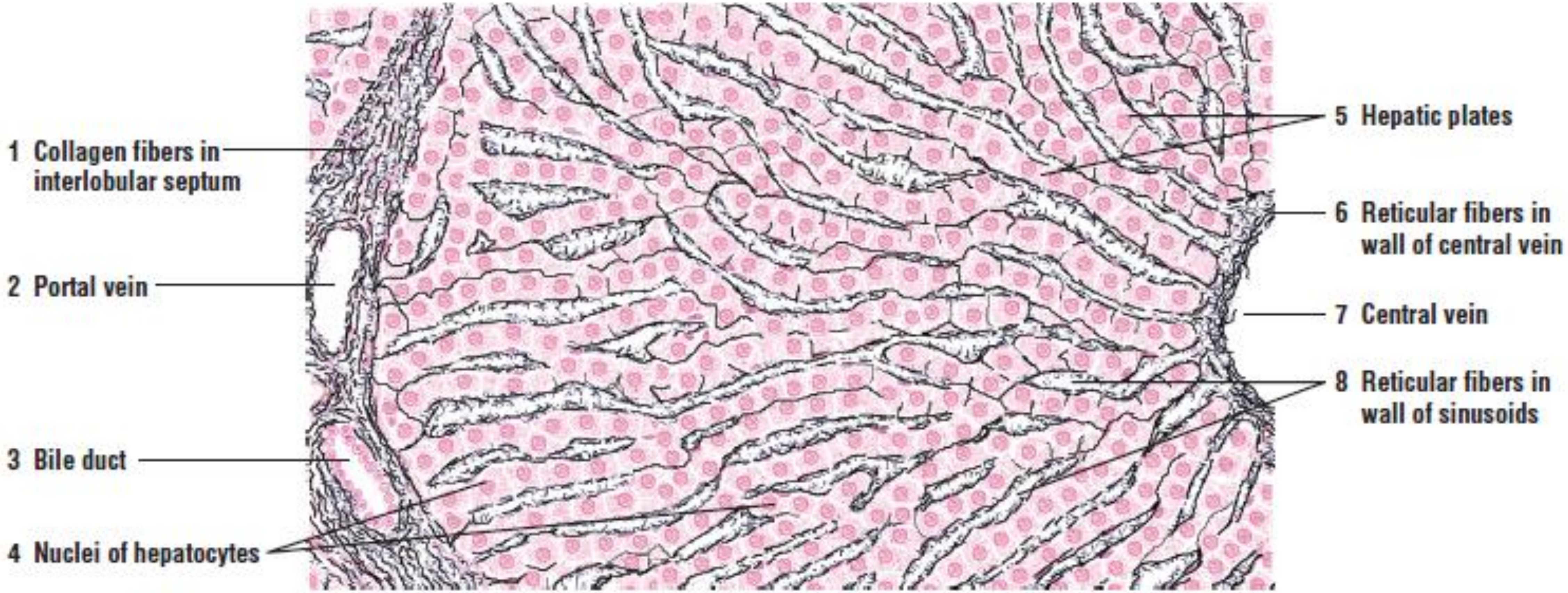


FIGURE 16.8 ■ Reticular fibers in liver lobule. Stain: reticulin method. Medium magnification.

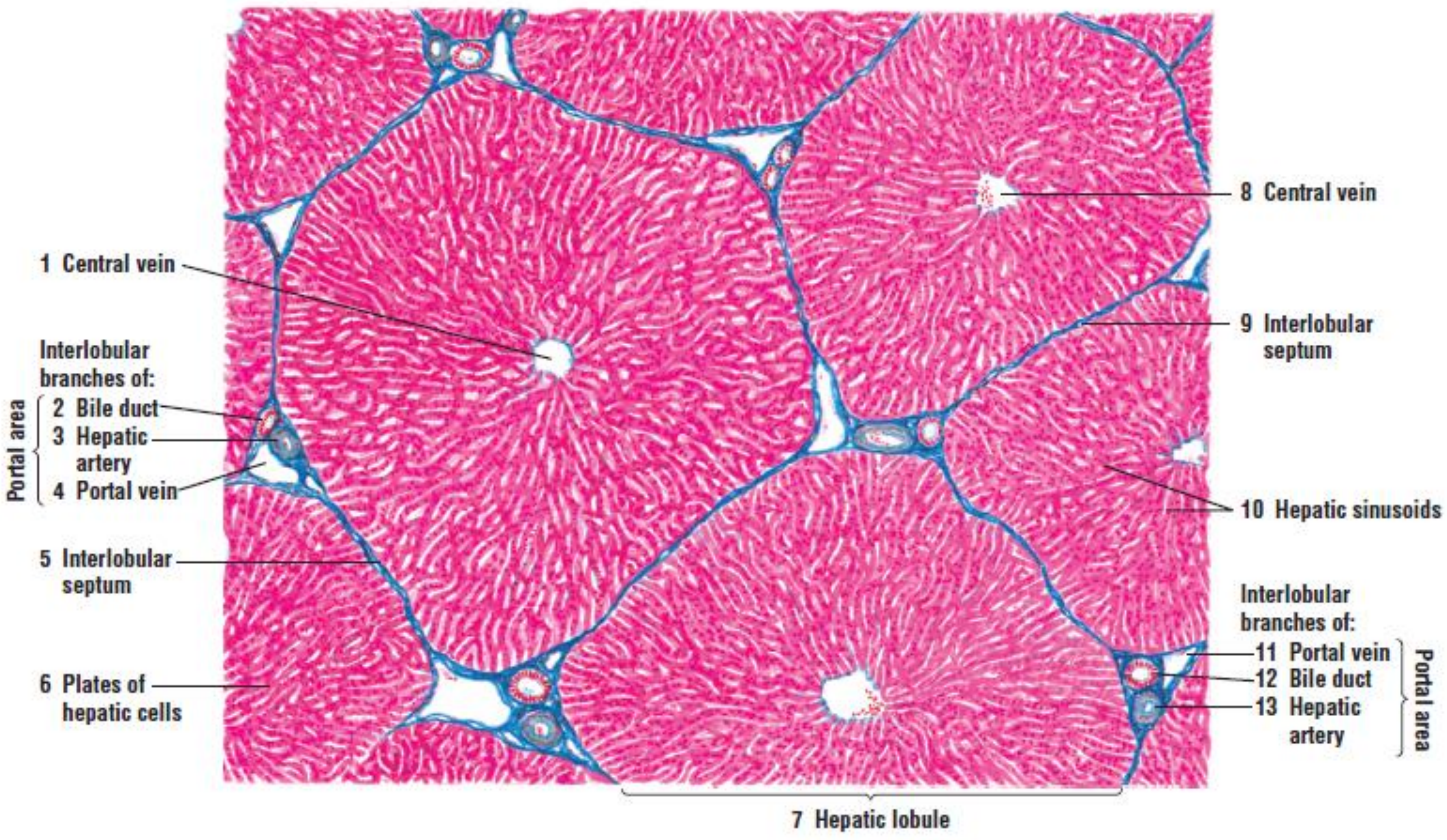


FIGURE 16.1 ■ Pig liver (panoramic view, transverse section). Stain: Mallory-Azan. Low magnification.

Ultrastructure of a hepatocyte. RER, rough endoplasmic reticulum; SER, smooth endoplasmic reticulum. x10,000.

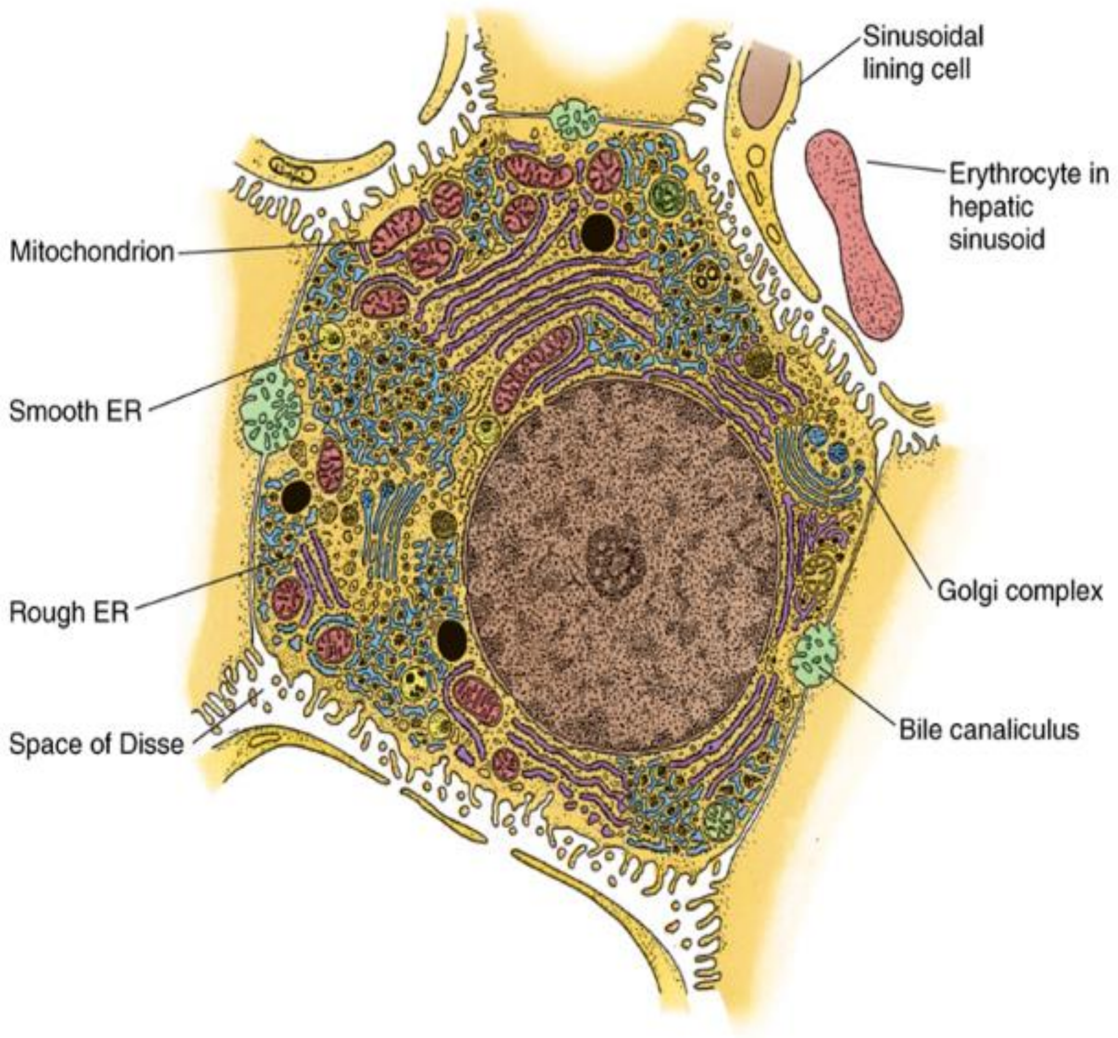
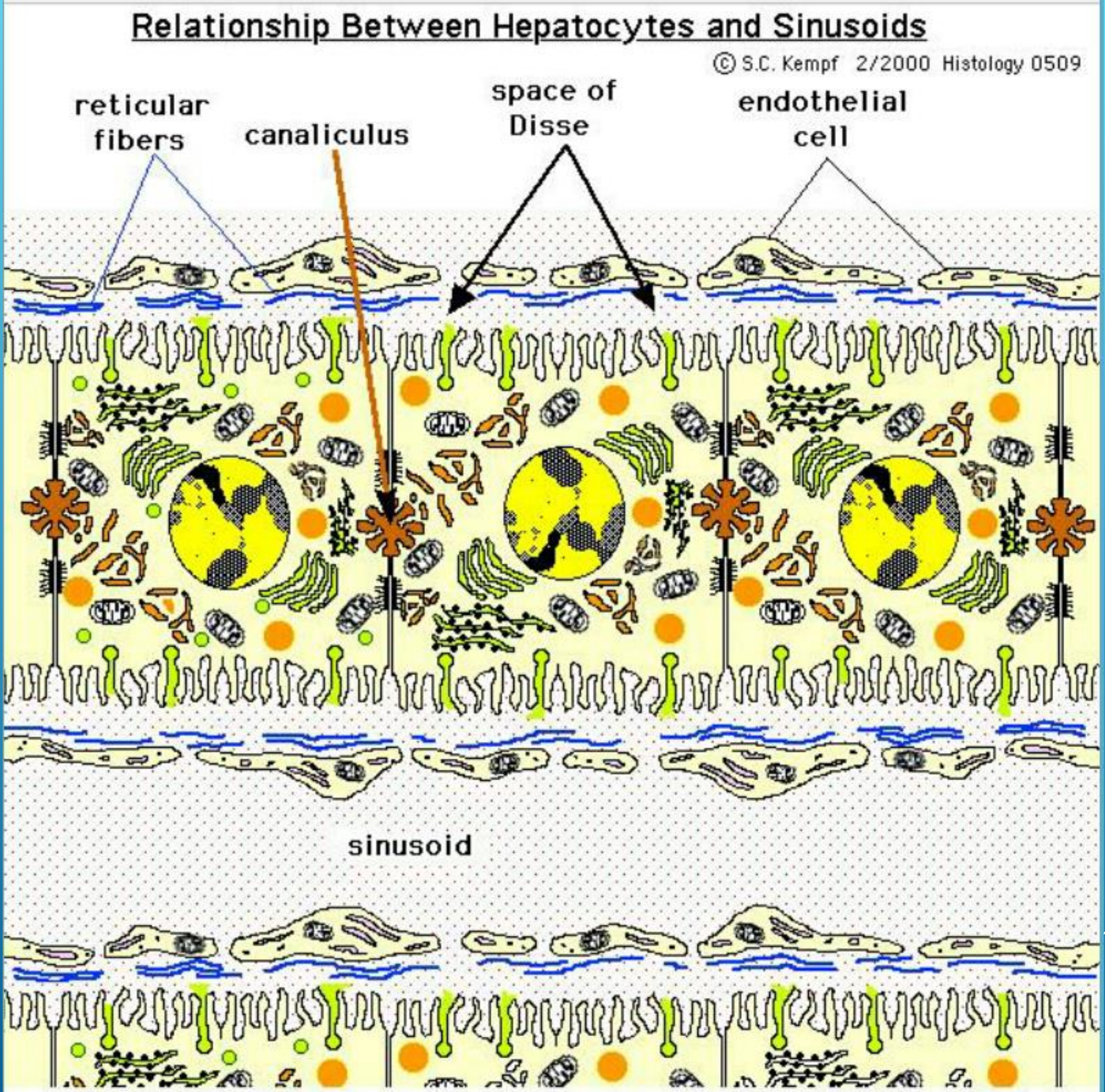
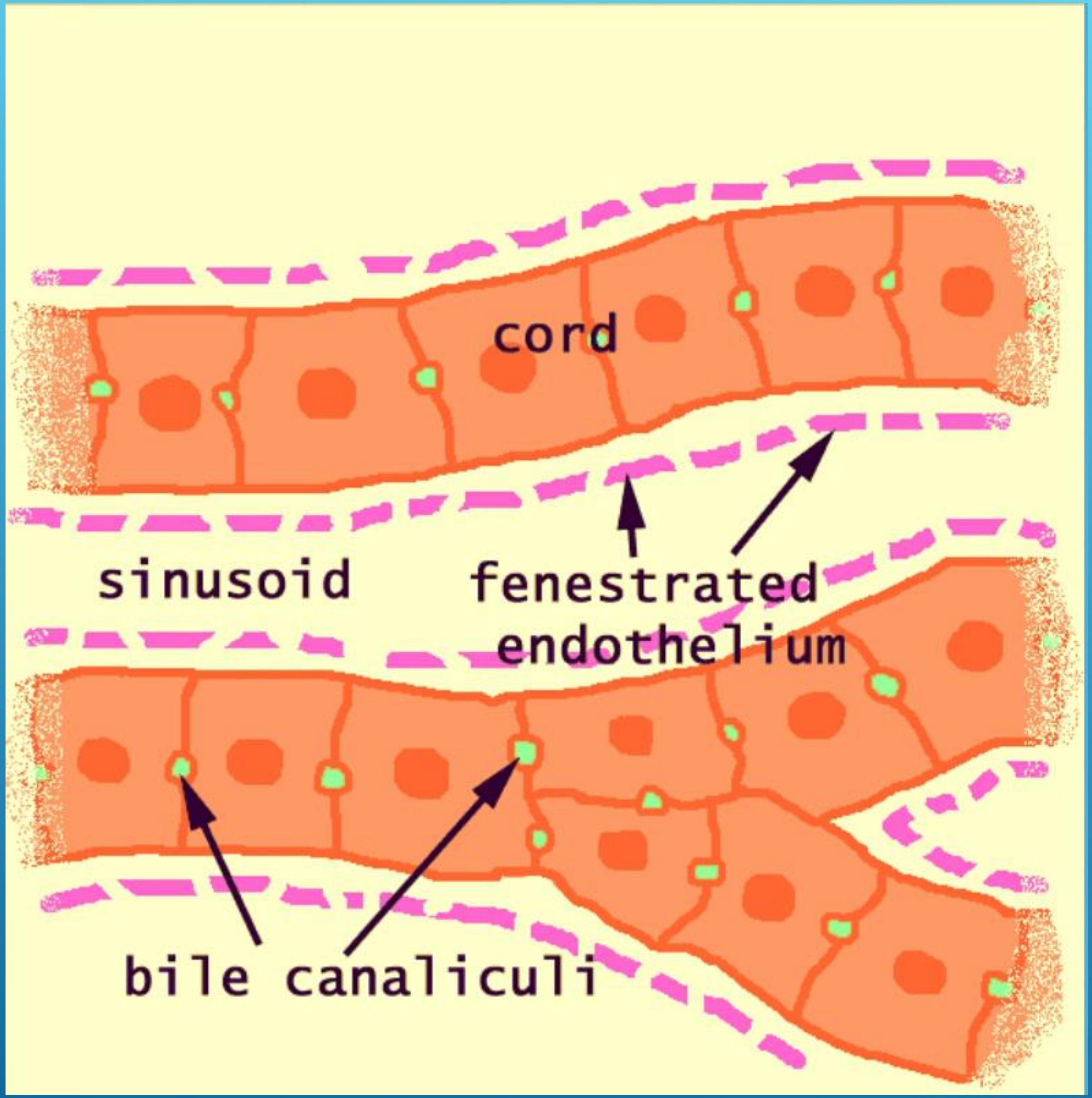
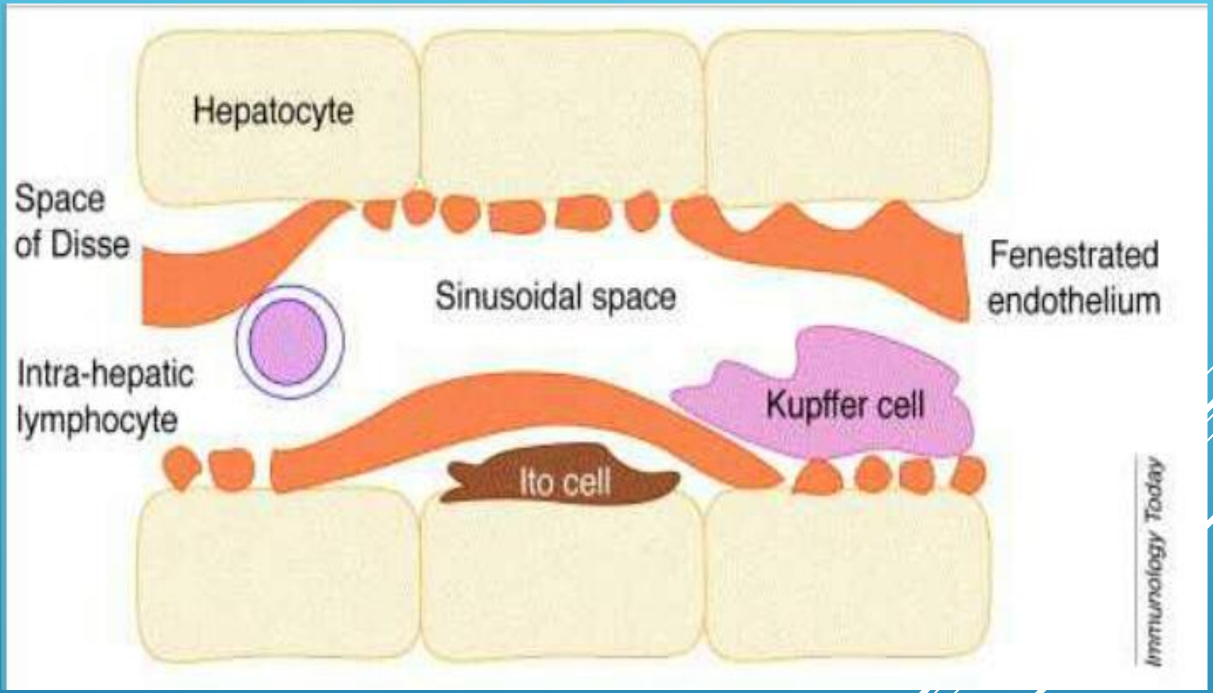


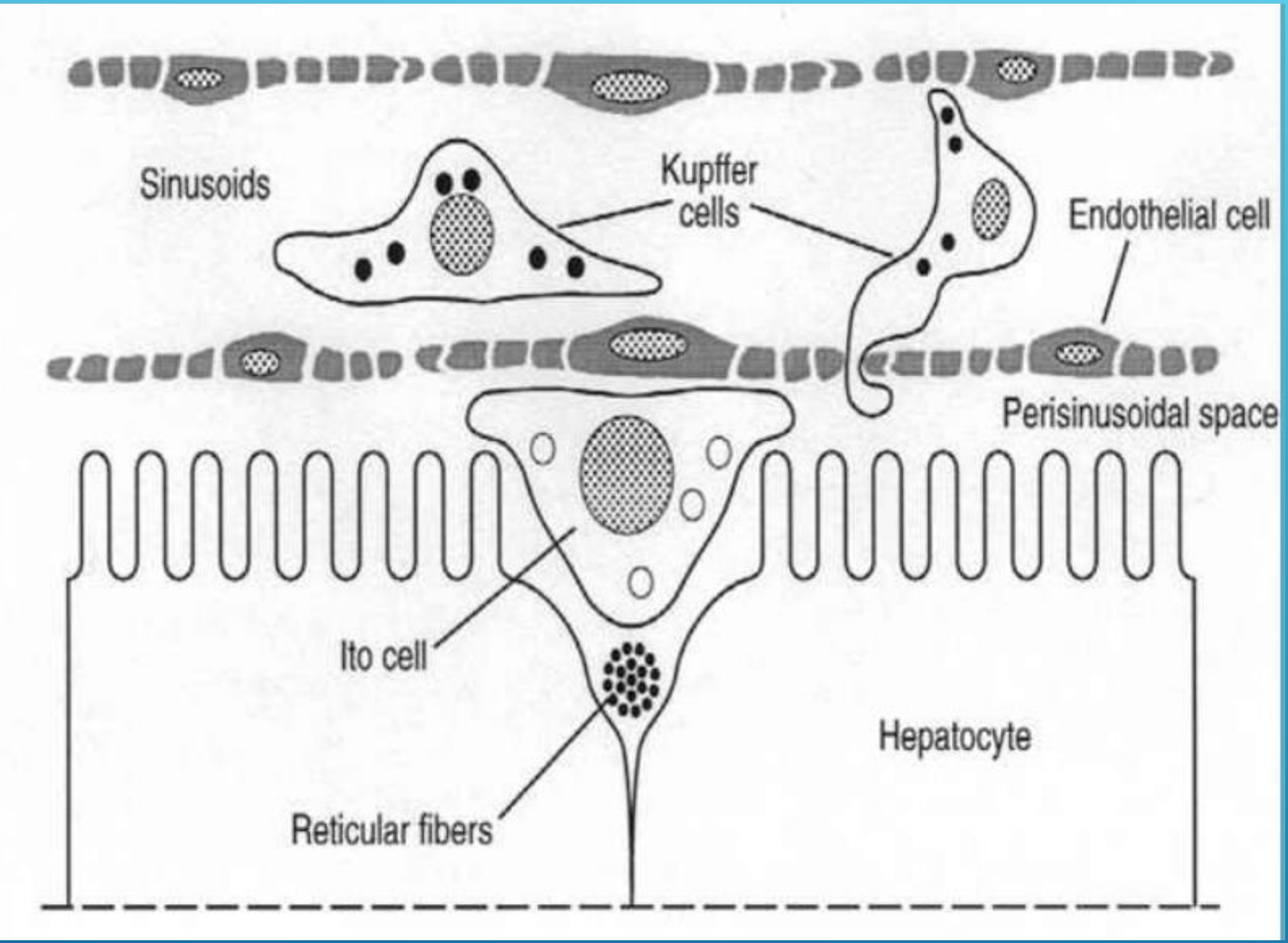
Figure 18-14 A hepatocyte and its sinusoidal and lateral domains. ER, endoplasmic reticulum. (From Lentz TL: Cell Fine Structure: An Atlas of Drawings of Whole-Cell Structure. Philadelphia, WB Saunders, 1971.)

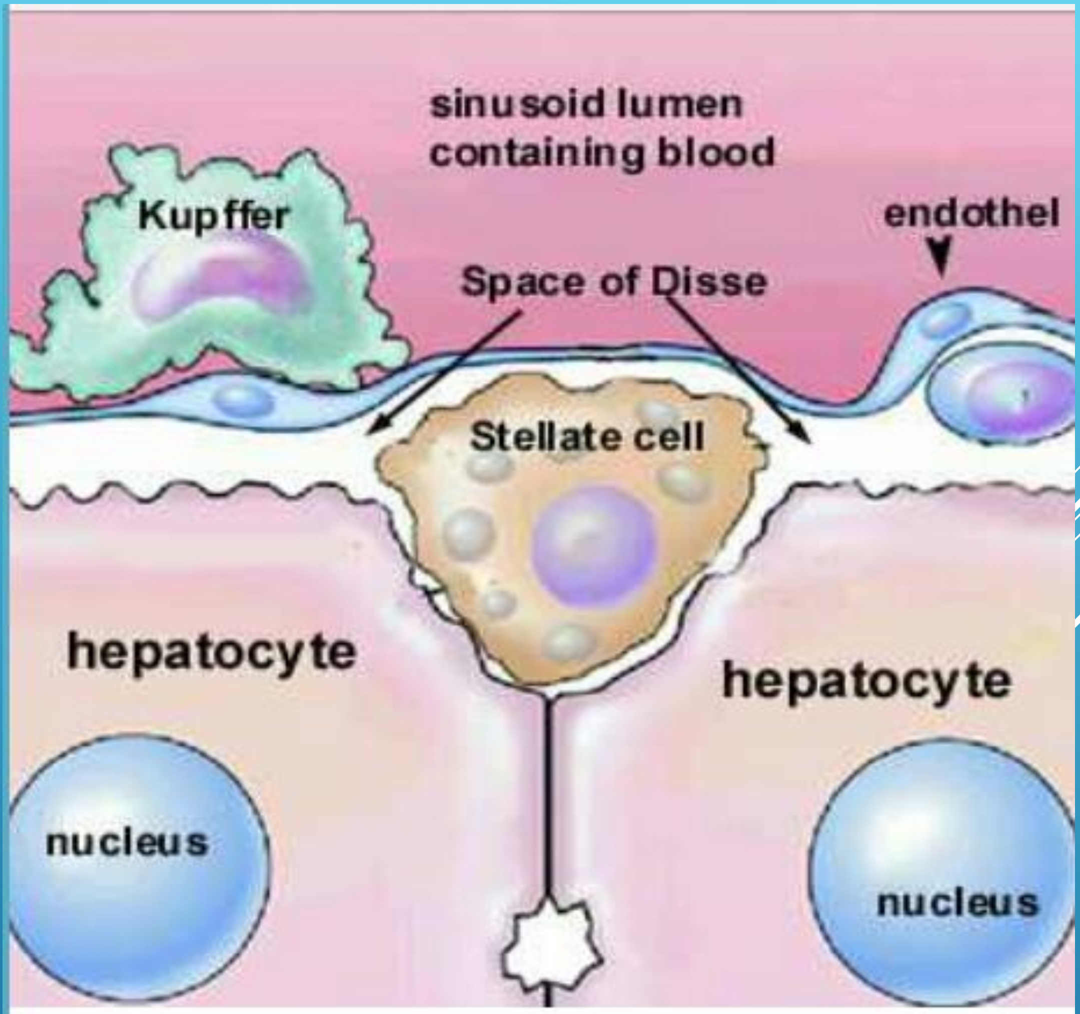


Relationship Between Hepatocytes and Sinusoids
© S.C. Kempf 2/2000 Histology 0509
reticular fibers
canaliculus
space of Disse
endothelial cell
sinusoid


cord
sinusoid
fenestrated
endothelium
bile canaliculi


Hepatocyte
Space
of Disse
Sinusoidal space
Fenestrated
endothelium
Intra-hepatic
lymphocyte
Kupffer cell
Ito cell
Immunology Today


Sinusoids
Kupffer cells
Endothelial cell
Perisinusoidal space
Ito cell
Reticular fibers
Hepatocyte


sinusoid lumen containing blood
Kupffer
endothel
Space of Disse
Stellate cell
hepatocyte
hepatocyte
nucleus
nucleus

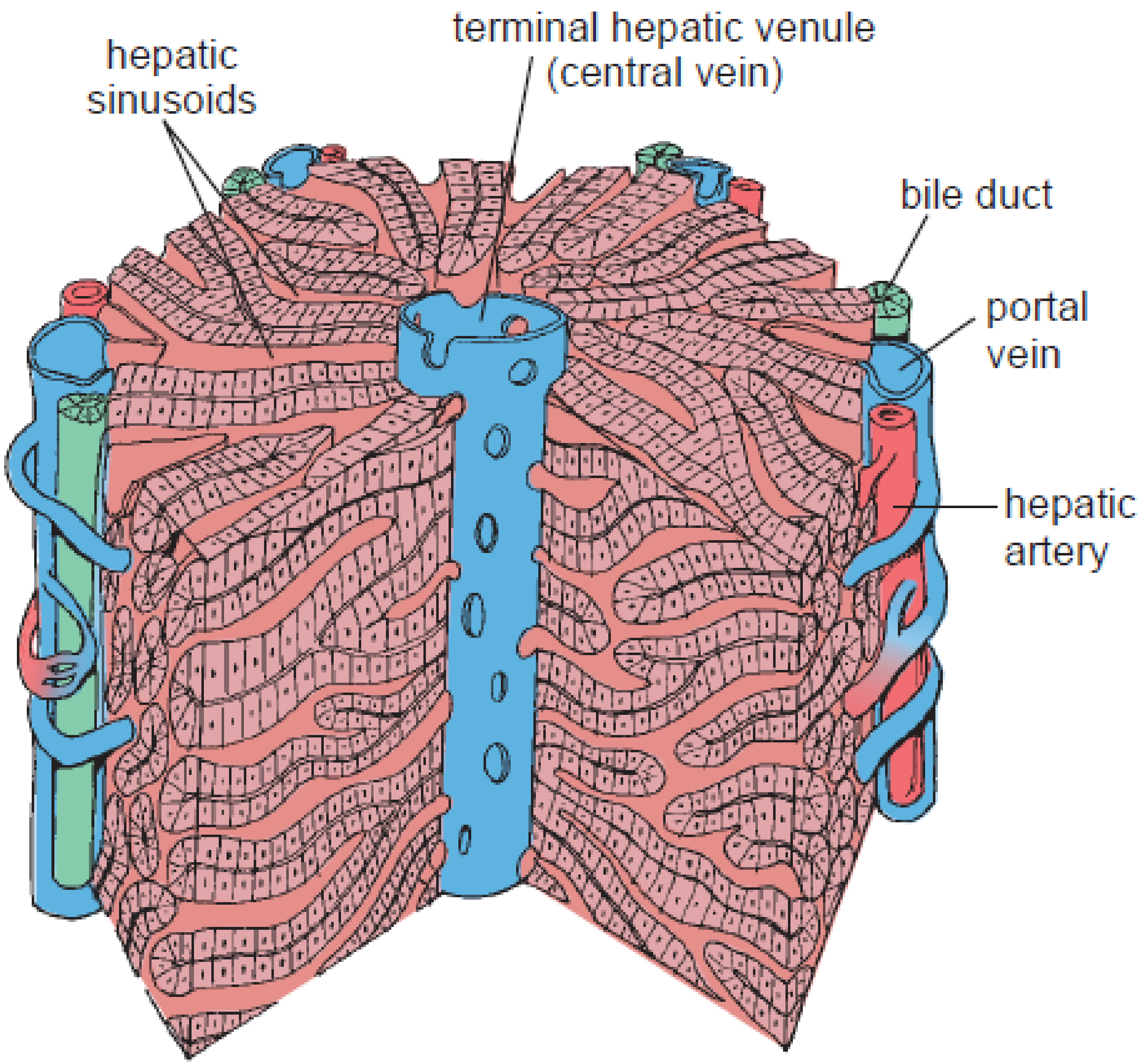
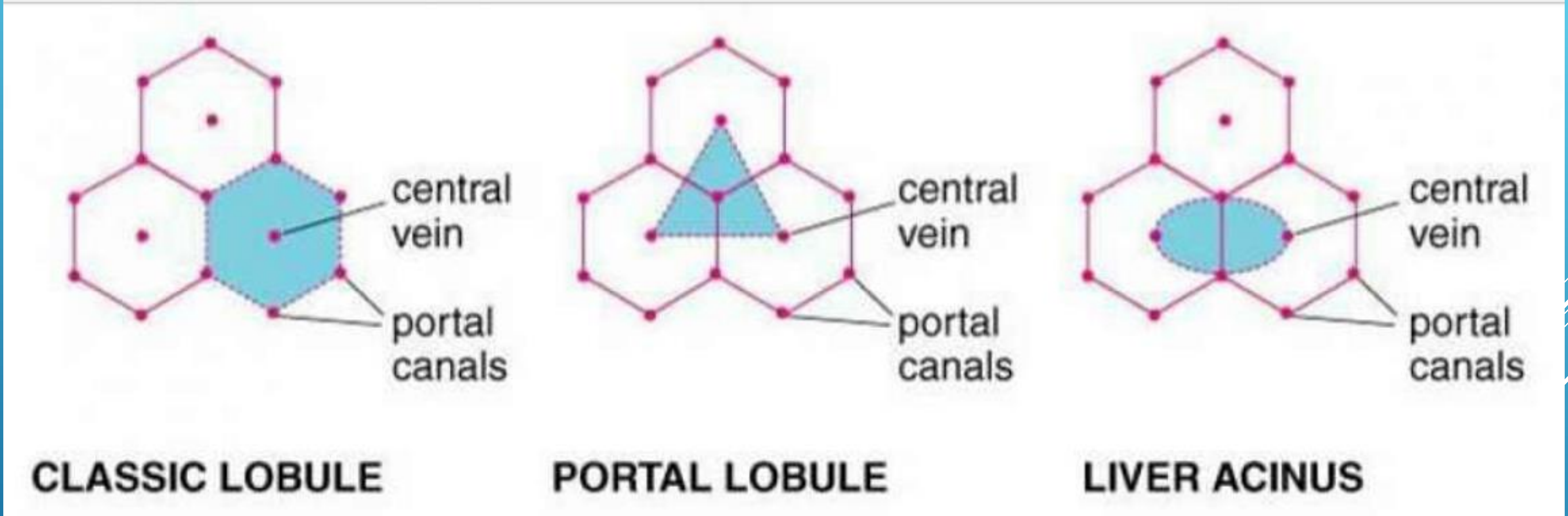


Diagram of a classic liver lobule.


central
vein
portal
canals
CLASSIC LOBULE
central
vein
portal
canals
PORTAL LOBULE
central
vein
portal
canals
LIVER ACINUS

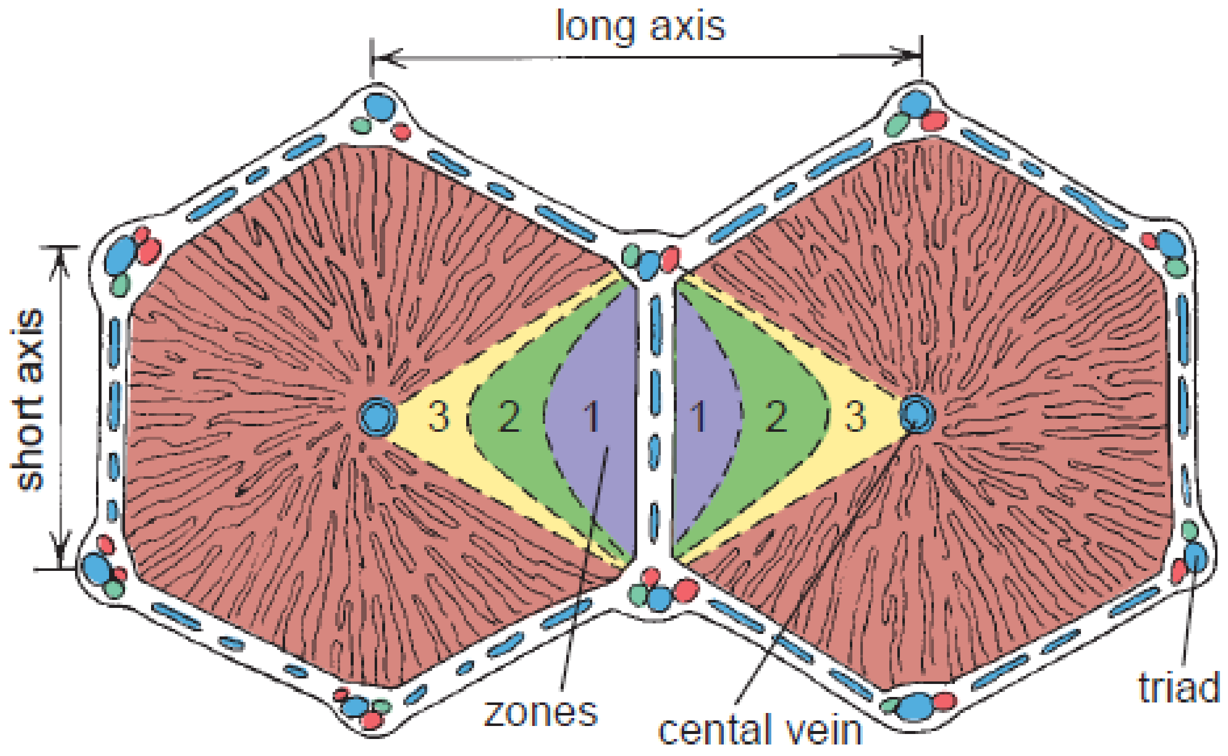
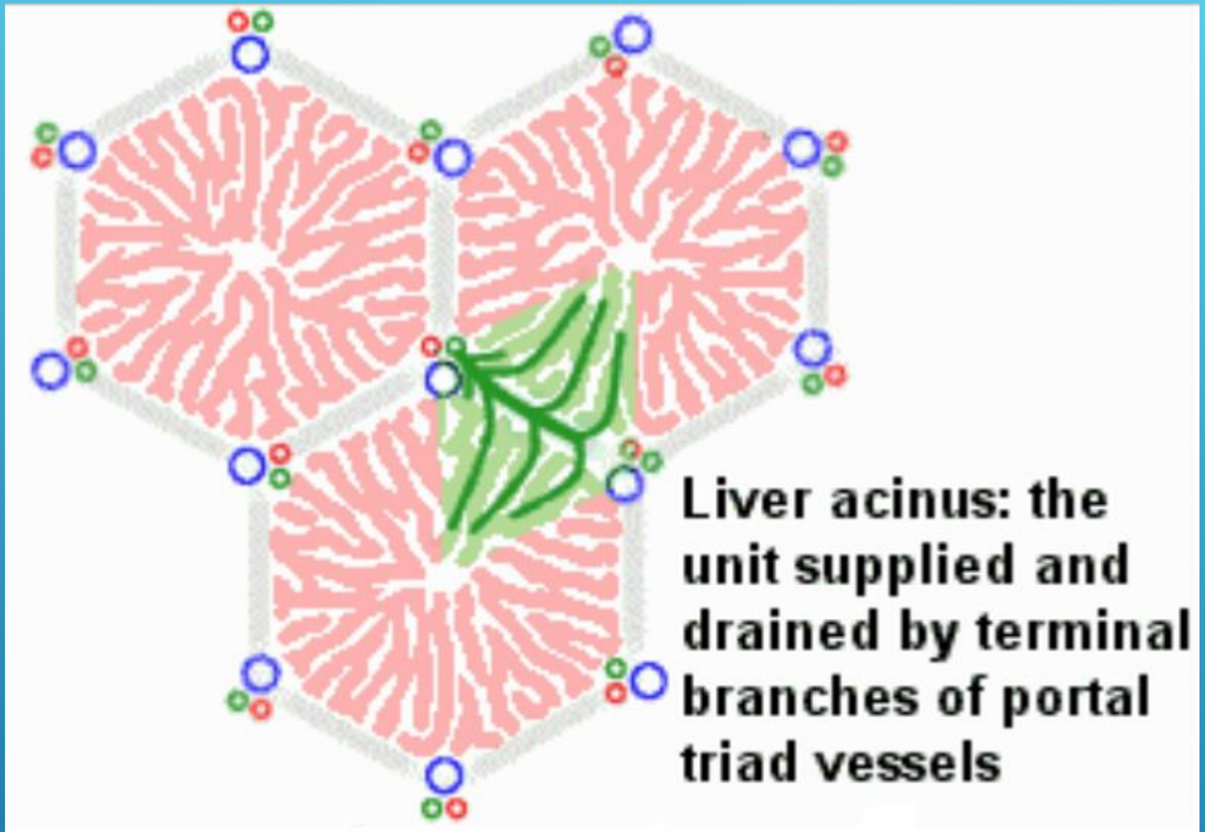
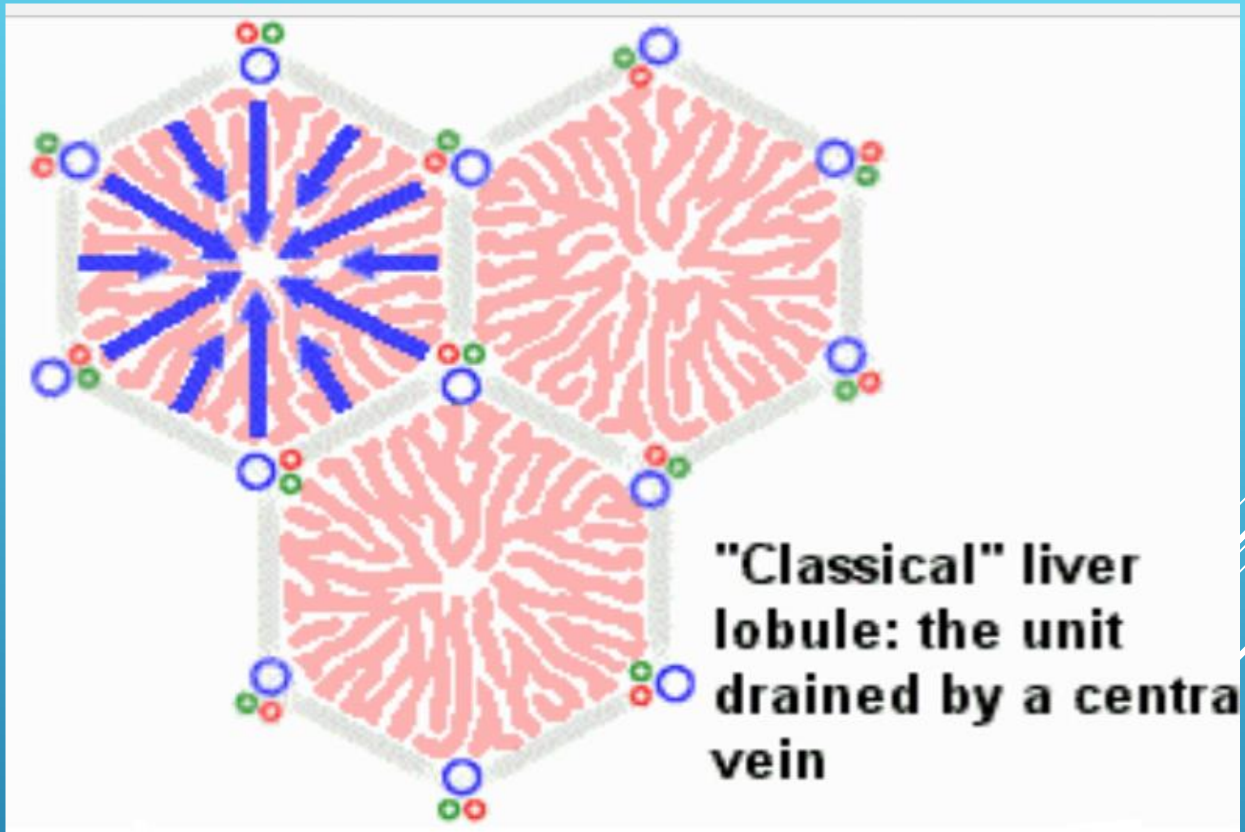


FIGURE 18.6 • **The liver acinus.** The liver acinus is a functional interpretation of liver organization. It consists of adjacent sectors of neighboring hexagonal fields of classic lobules partially separated by distributing blood vessels. The zones, marked 1, 2, and 3, are supplied with blood that is most oxygenated and richest in nutrients in zone 1 and least so in zone 3. The terminal hepatic venules (central veins) in this interpretation are at the edges of the acinus instead of in the center, as in the classic lobule. The vessels of the portal canals, namely, terminal branches of the portal vein and hepatic artery that, along with the smallest bile ducts, make up the portal triad, are shown at the corners of the hexagon that outlines the cross-sectioned profile of the classic lobule.



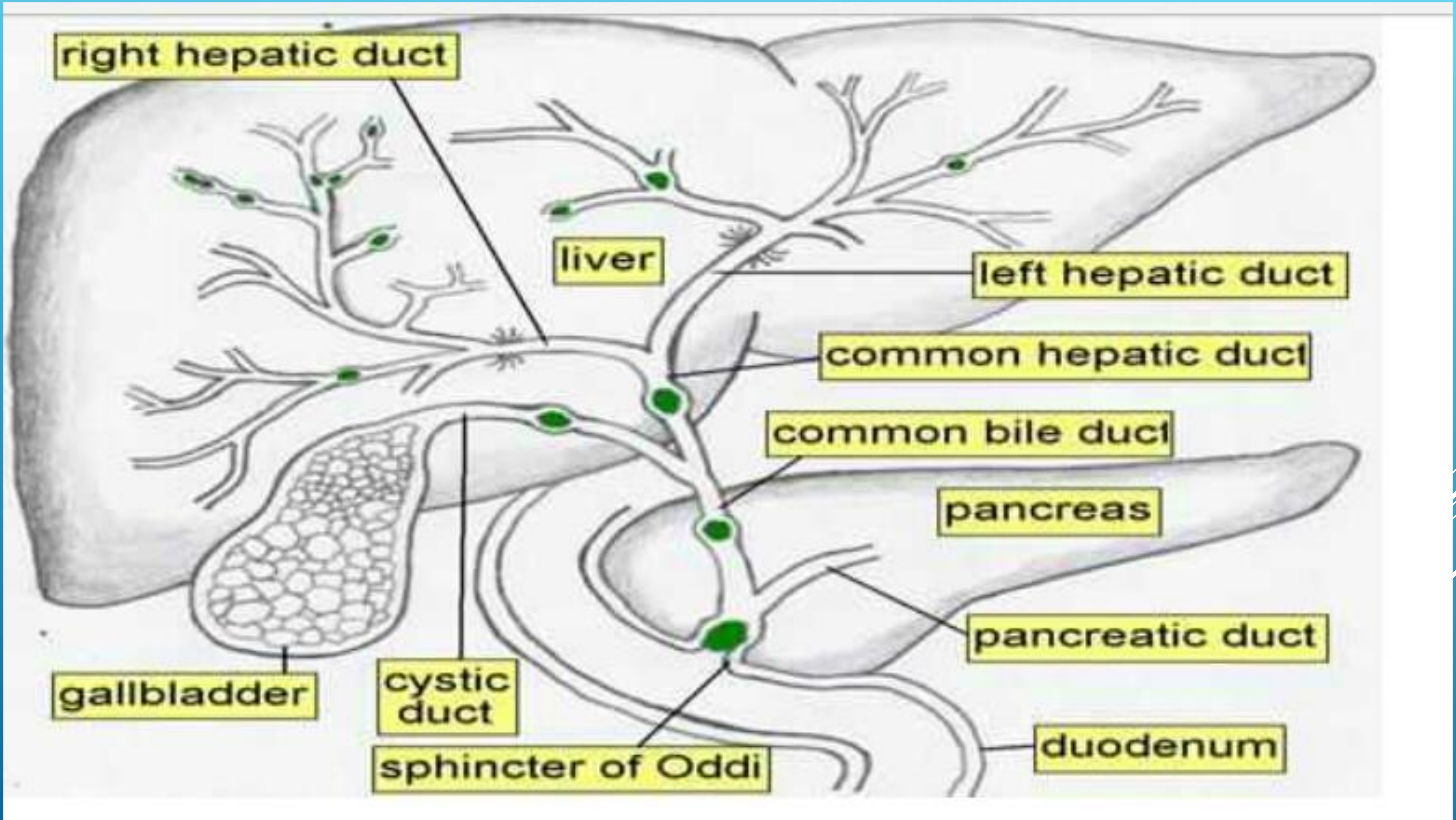
NB;

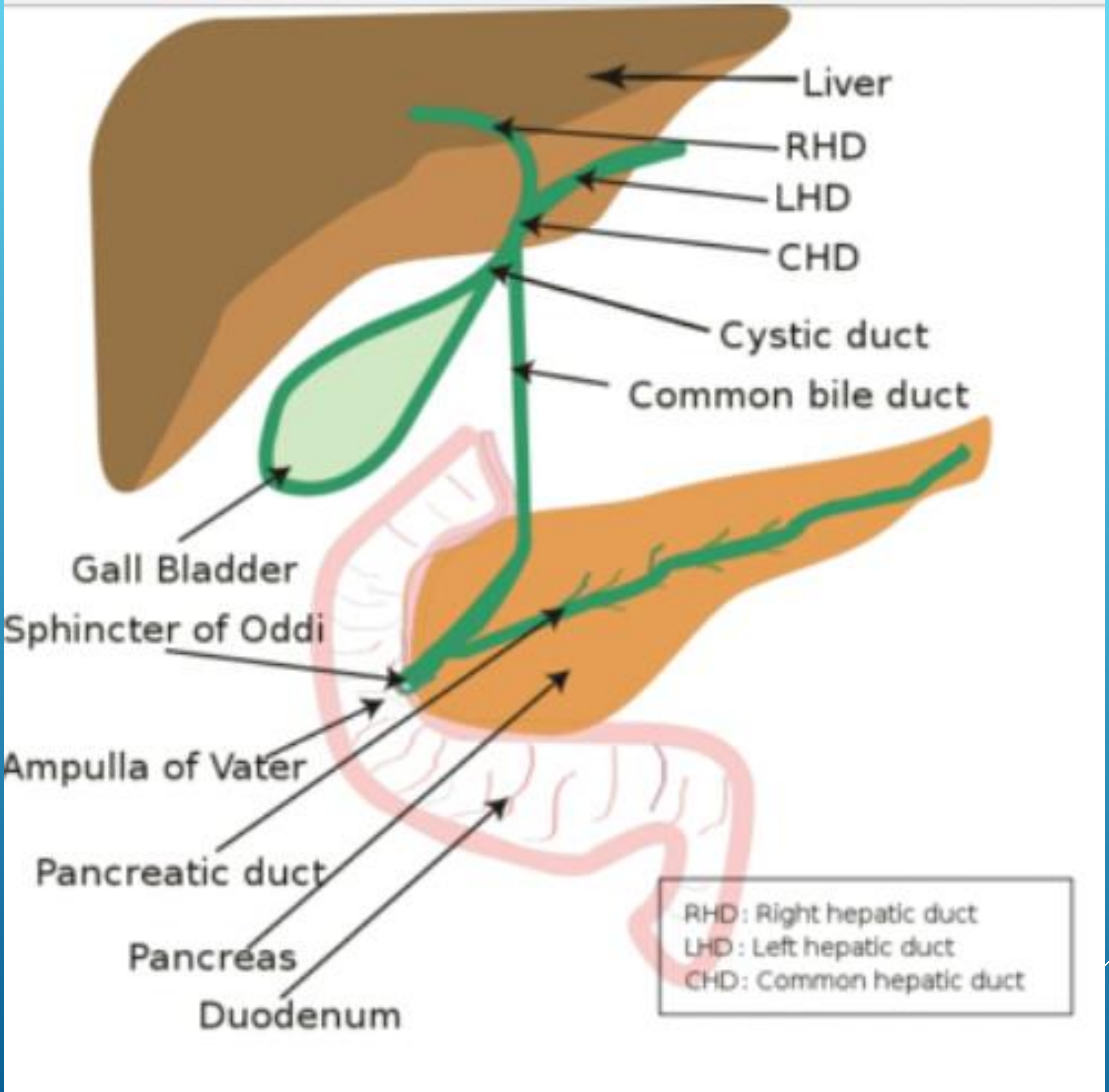
- the bile flows away from the central vein



NB;

- the blood flows towards the central vein


right hepatic duct
liver
left hepatic duct
common hepatic duct
common bile duct
pancreas
pancreatic duct
gallbladder
cystic duct
sphincter of Oddi
duodenum


Liver
RHD
LHD
CHD
Cystic duct
Common bile duct
Gall Bladder
Sphincter of Oddi
Ampulla of Vater
Pancreatic duct
Pancreas
Duodenum
RHD : Right hepatic duct
LHD : Left hepatic duct
CHD : Common hepatic duct

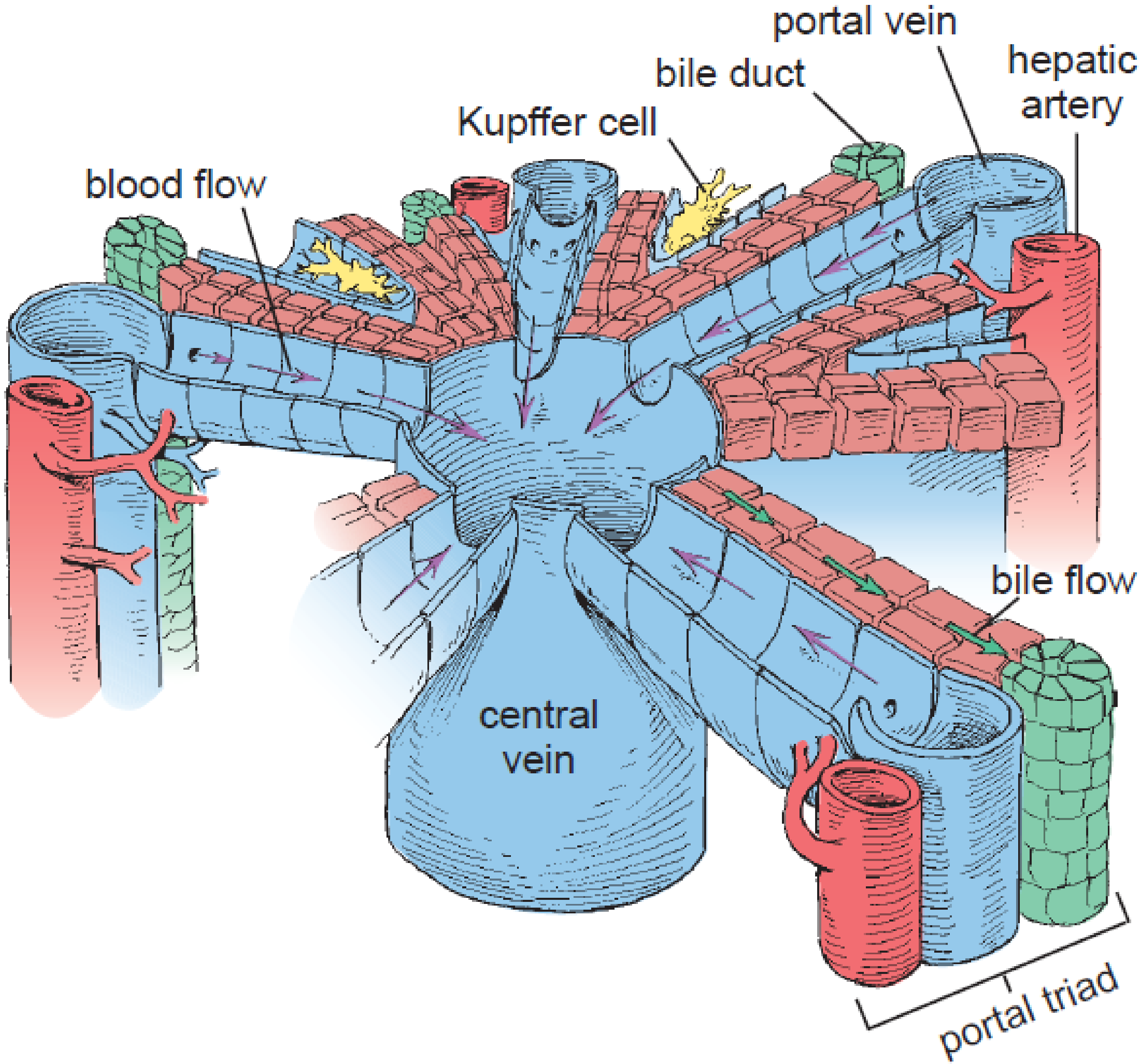
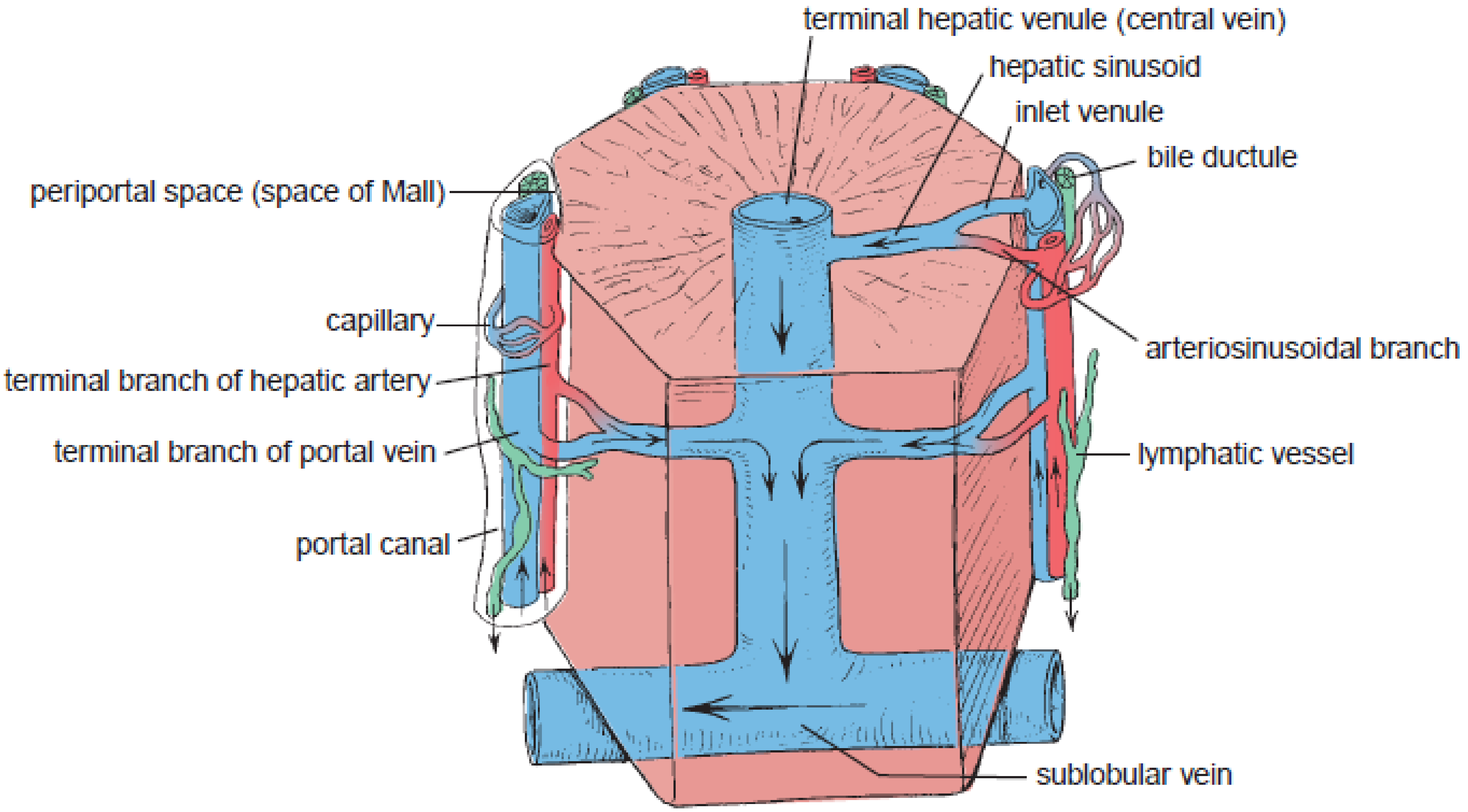
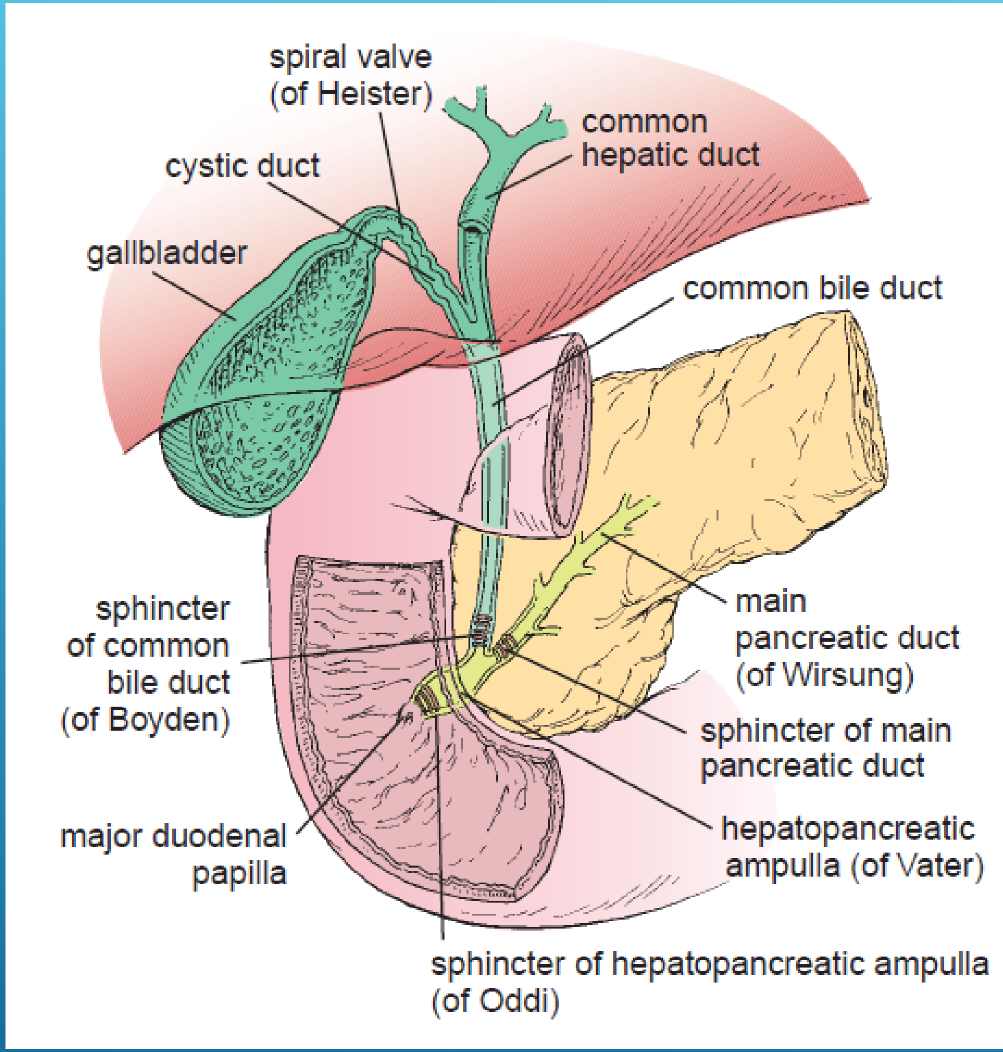


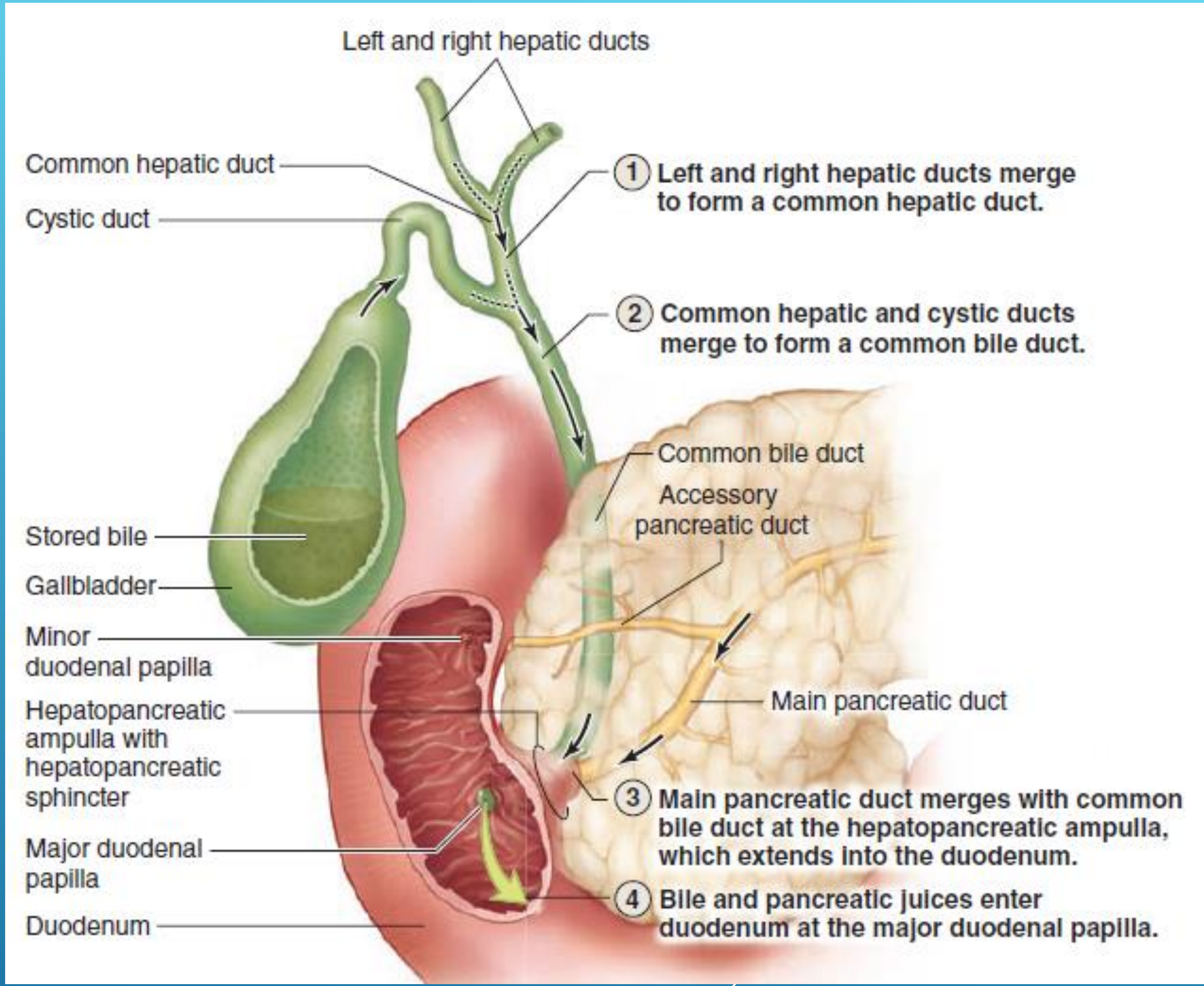
Diagram of the flow of blood and bile in the liver

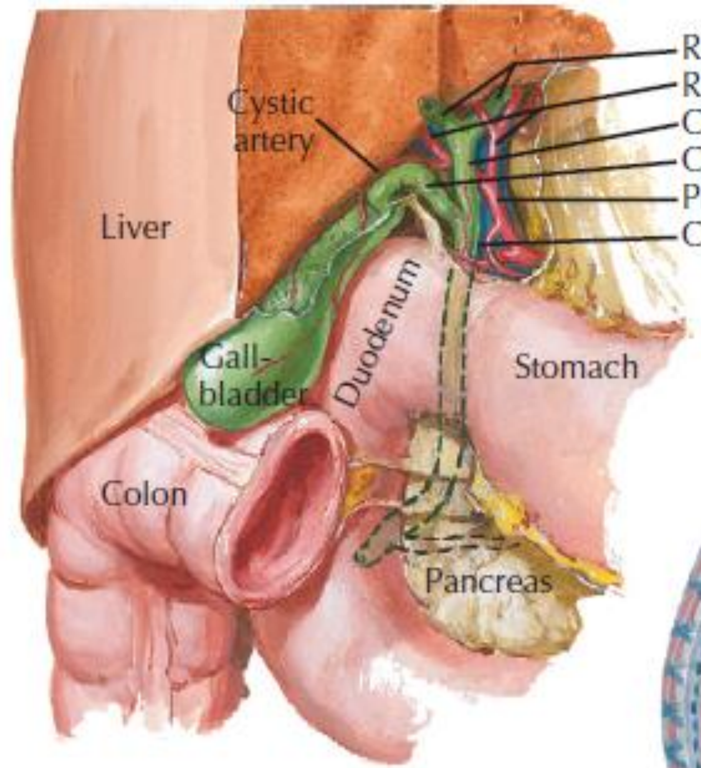


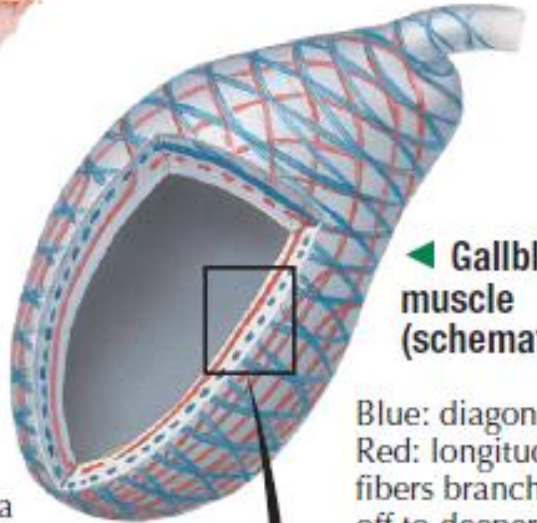
BLOOD SUPPLY TO THE LIVER: THE PORTAL TRIAD

GALL BLADDER


spiral valve
(of Heister)
common
hepatic duct
cystic duct
gallbladder
common bile duct
main
pancreatic duct
(of Wirsung)
sphincter
of common
bile duct
(of Boyden)
sphincter of main
pancreatic duct
major duodenal
papilla
hepatopancreatic
ampulla (of Vater)
sphincter of hepatopancreatic ampulla
(of Oddi)


Left and right hepatic ducts
Common hepatic duct
Cystic duct
1 Left and right hepatic ducts merge to form a common hepatic duct.
2 Common hepatic and cystic ducts merge to form a common bile duct.
Common bile duct
Accessory pancreatic duct
Stored bile
Gallbladder
Minor duodenal papilla
Main pancreatic duct
Hepatopancreatic ampulla with hepatopancreatic sphincter
3 Main pancreatic duct merges with common bile duct at the hepatopancreatic ampulla, which extends into the duodenum.
Major duodenal papilla
4 Bile and pancreatic juices enter duodenum at the major duodenal papilla.
Duodenum





Gallbladder muscle (schematic).

Blue: diagonal fibers
Red: longitudinal fibers branching off to deeper level

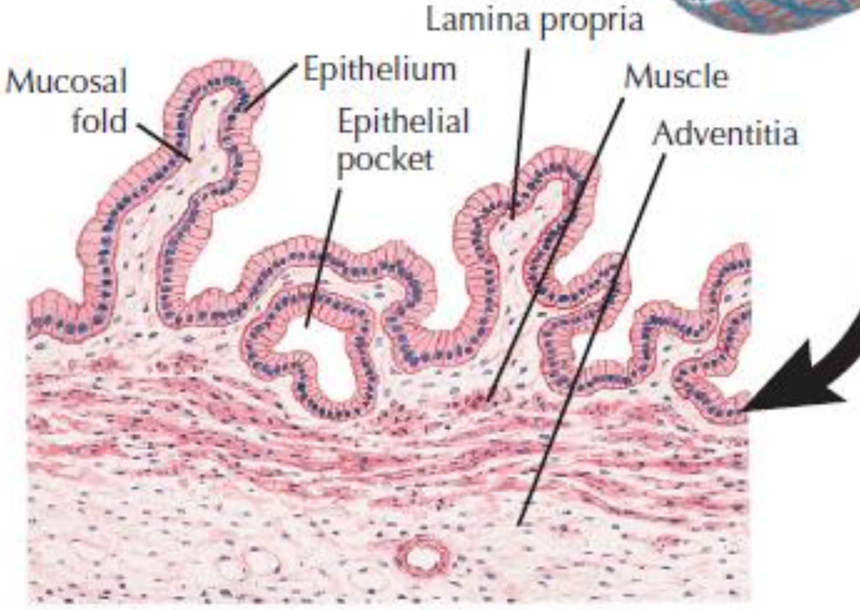
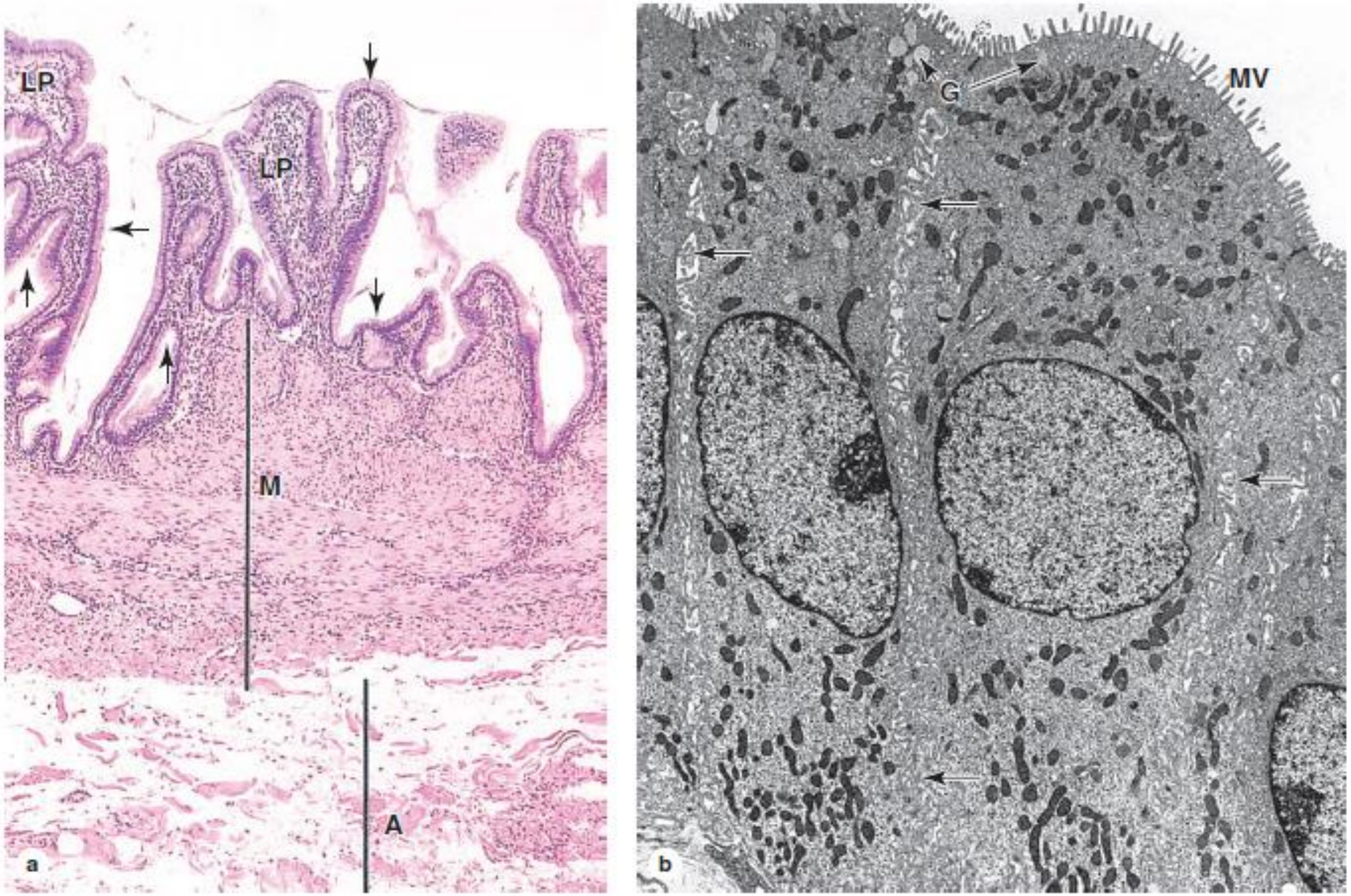


FIGURE 16.15 ■ Wall of the gallbladder. Stain: hematoxylin and eosin. Low magnification.



The gallbladder is a saclike structure that stores and concentrates bile, and releases it into the duodenum after a meal. **(a)** Its wall consists largely of a highly folded mucosa, with a simple columnar epithelium (arrows) overlying a typical lamina propria (**LP**); a muscularis (**M**) with bundles of muscle fibers oriented in all directions to facilitate emptying of the organ; and an external adventitia (**A**) where it is against the liver and a serosa where it is exposed. X60. H&E.

(b) TEM of the epithelium shows cells specialized for water uptake across apical microvilli (**MV**) and release into the intercellular spaces (**arrows**) along the folded basolateral cell membranes. From these spaces water is quickly removed by capillaries in the lamina propria. Abundant mitochondria provide the energy for this pumping process. Scattered apical secretory granules (**G**) contain mucus. X5600.

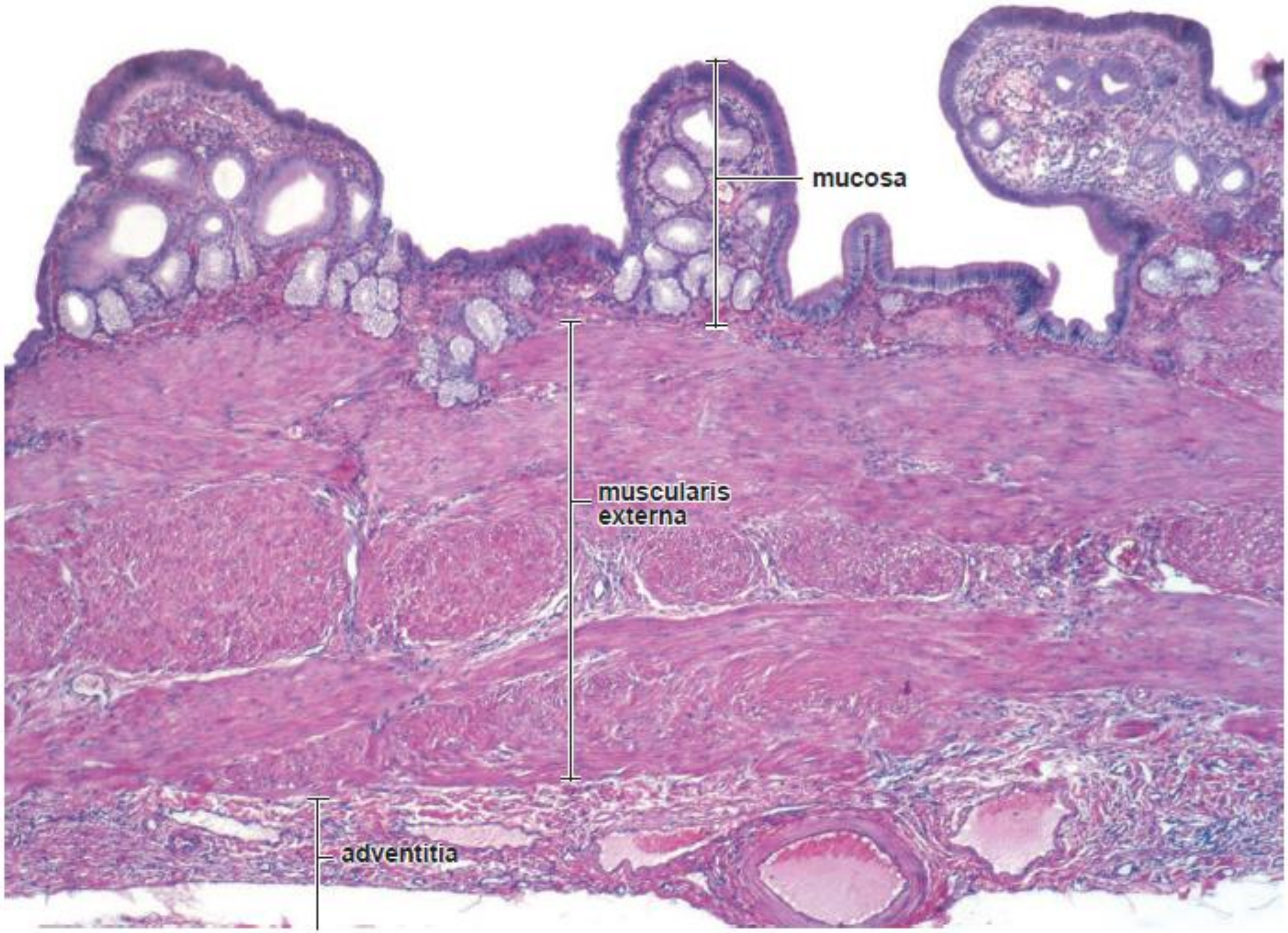


FIGURE 18.16 • **Photomicrograph of the wall of the gallbladder.** The mucosa of the gallbladder consists of a lining of simple columnar epithelial cells and a lamina propria of loose connective tissue, which typically exhibits numerous deep folds in the mucosa. Beneath this layer is a relatively thick layer, the muscularis externa. There is no muscularis mucosae or submucosa. The smooth muscle bundles of the muscularis externa are randomly oriented. External to the muscle is an adventitia containing adipose tissue and blood vessels. The portion of the gallbladder not attached to the liver displays a typical serosa instead of an adventitia. ×175.

REFERENCES

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